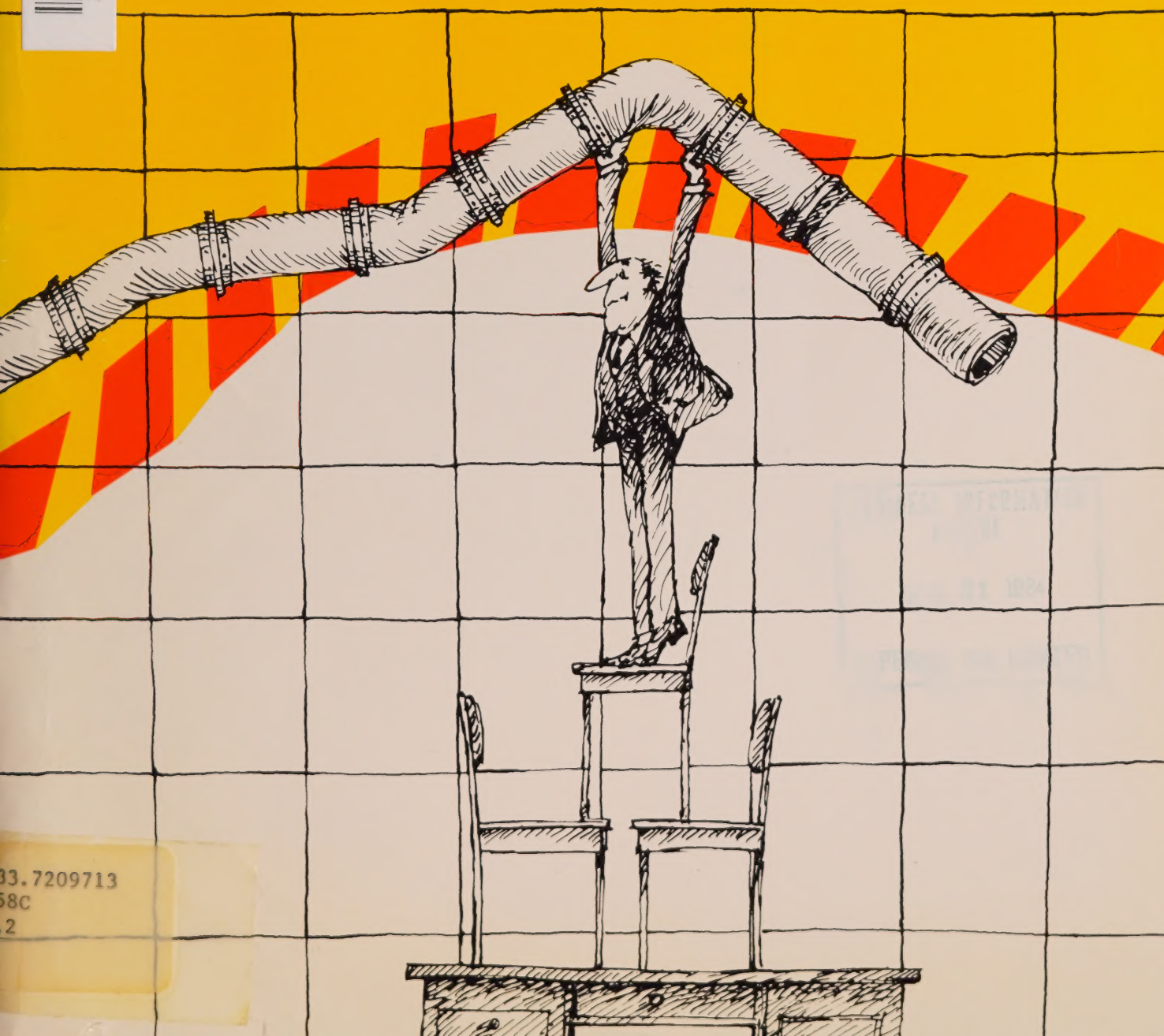
Ontario Energy Review

$5.00
September, 1983

3rd edition

Ministry
of
Energy
Ontario

Honourable
Philip Andrewes
Minister



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Ontario Energy Review Errata

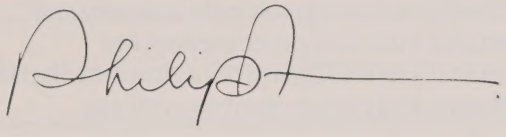
Figure	Page	Error	Correction
9	13	Legend is inaccurate.	The legend should read: Solid red line – Old oil; Dotted black line – Old oil and conventional area new oil; Dotted red line – Old oil, conventional new oil, and existing oil sands; Solid black line – Total supply including new oil sands; Broken red line – Total demand.
12	15	Dot showing St. Catharines is located inaccurately.	Place dot for St. Catharines 1/2 cm to the left.
13	15	Heavy fuel oil is shown as 13.0% of refinery production in 1982.	Change 13.0 to 13.6
14	17	Natural Gas production shares for Canada, Western Europe and Others are incorrect.	These should read: 5%, 12% and 5% respectively.
16	18	Canada Lands are not identified in the map.	Delete: '□ Outline of Canada Lands' from legend.
17	19	Chart does not distinguish the area representing 'Estimated exports (existing licences)'.	To correct this, draw a line passing through the following points: 1982 1917 petajoules/year 1985 2309 petajoules/year 1987 2471 petajoules/year 1990 2633 petajoules/year 1992 2794 petajoules/year Line meets the solid black line in 1993. The orange area above this line is 'Estimated exports (existing licences)' and it should be shaded dark brown to match the legend.
20	21	TransCanada PipeLine connection to Ottawa is missing.	Connect Ottawa to the TransCanada PipeLine system, east of Brockville. Also note that Northern and Central Gas Limited serves a small area near Brockville.
29	30	Note accompanying this chart is incomplete.	The note should read, "Direct Sales by Ontario Hydro are shown in upper three sections, and sales by municipal utilities are shown in the bottom two sections."
31	33	Legend and graph are inaccurate.	Legend should read: Black line – Montreal landed price, Saudi light crude 1970-73 and total imports post-1973. Re-draw black line to show $41.60 in July 1982, $40.24 in January 1983 and $36.02 in July 1983. Add a footnote to the chart to read, 'Prices are not adjusted for quality differences.'
41	41	The units of measurement are not specified in this chart.	The units should be 'million cubic metres of oil equivalent'.
51	52	The numbers in the chart for 1971 add to 98% instead of 100%.	Add a small wedge for 'Other fuel*', representing 2%. *refers to wood & propane.

Foreword

I am pleased to introduce the third edition of the Ontario Energy Review.

This edition emphasizes developments in Ontario in relation to the national and international energy scene. Ontario is not self-sufficient in energy, and it is not isolated from energy-related developments that occur beyond its border. By understanding how national and international events affect Ontario, we can comprehend our current energy situation better and plan for the challenges we will face in the years to come.

The Ontario Energy Review contains the most recent statistics available on energy in Ontario and explains them for those who are not specialists in the field. I hope that it will help the public gain a greater awareness of energy matters in our province.



Hon. Philip Andrewes
Minister of Energy

September, 1983

Contents

Overview

Approximately one-quarter of the energy used in Ontario comes from provincial resources, mainly water-power and uranium. The province has little oil, natural gas or coal. Virtually all the oil and gas consumed in Ontario comes from Alberta, and most of the coal is imported from the United States.

The quadrupling of world oil prices in 1973-74 and the subsequent doubling of these prices in 1979-80 have contributed to higher inflation, lower economic growth and increased unemployment.

In 1982, Ontario's refineries and utilities spent approximately nine billion dollars for crude oil and natural gas obtained from outside the province. This was twice the 1979 level despite reduced consumption of these fuels. Ontario's energy bill has become a large and growing economic burden on the people of the province.

Ontario consumes one-third of Canada's energy. About three-quarters of its energy supply comes from outside Ontario.

In October, 1980, the Ontario government introduced a long-term strategy to help the province become more energy efficient and less dependent on oil. It established energy efficiency and oil substitution targets for the residential, commercial, industrial and transportation sectors. At the same time, it adopted specific conservation targets for its own operations.

Ontario's energy goals for the 1980's and 1990's stress continued energy conservation and less dependence on oil.

The Ontario government set a goal to increase the amount of energy produced from indigenous sources. The goal is to produce 37.5 per cent of Ontario's primary energy needs (see glossary) from indigenous sources by 1995, compared with 25 per cent in 1980. Part of this target is to produce five per cent of Ontario's primary energy from renewable and recoverable resources, other than hydraulic power, by 1995.

To help reach these targets, the provincial government sponsors a variety of conservation and renewable energy demonstration programs across Ontario. The federal government also funds several conservation and renewable energy programs in the province as part of its national energy policy.

By reducing its dependence on oil, Ontario is contributing to the national goal of oil self-sufficiency.

Across Ontario, households and businesses are curbing energy use. Average household consumption of oil, natural gas and electricity has fallen in the past three years. Industries are finding ways to reduce their energy demands per unit of output. Also, space heating in commercial, institutional and government buildings is becoming more efficient. Conservation programs already in place, rising energy prices and slow economic growth are helping reduce energy use in the province. Substitution from oil to natural gas, electricity and renewable energy is also well underway throughout the province.

Despite these conservation and substitution trends, Ontario will continue to depend on oil for much of its energy needs well into the future. To give Ontario an active role in the future search for oil and to assist in the Canadianization of the petroleum industry, the Ontario government, through the Ontario Energy Corporation (OEC), purchased 25 per cent of the shares of Suncor Inc. in 1981. In 1982, OEC and Suncor formed the Trillium Exploration Corporation to explore for oil and gas in frontier regions of Canada.

Nations around the world are becoming more efficient in the use of energy.

Like its predecessors, this edition of the Ontario Energy Review contains two sections. The first, Energy Update, describes recent trends in the supply and use of energy in Ontario and examines the province's energy production and distribution networks. It also reviews federal-provincial energy pricing arrangements and developments in Ontario in the areas of renewable energy and conservation.

The second section, Energy Outlook, discusses how Ontario's energy picture may change between now and the year 2000. Probable patterns of energy use are projected, and the supply prospects are explored.

Energy Update

Ontario's Energy

Ontario uses more energy than any other province. In fact, the energy used in Ontario accounts for one-third of total Canadian requirements. However, this proportion is less than the province's share of the country's population and economic output.

The charts in this section refer to primary energy use. Primary energy relates to the energy contained in such sources as crude oil, natural gas, coal, water-power and uranium. Much of this energy is converted to secondary fuels (or secondary energy). For instance, crude oil is a form of primary energy which is converted to such secondary energy fuels as heating oil and gasoline. Likewise, electricity is a form of secondary energy produced from the primary energy sources of water-power, uranium and coal. The "Primary and Secondary Energy in Ontario" chart on page 63 gives a more detailed explanation of the relationship between primary and secondary energy.

Crude oil meets approximately 35 per cent of Ontario's primary energy needs, natural gas 23 per cent, coal 16 per cent, uranium 13 per cent and water-power 12 per cent (Figure 1). The forest products industry burns its residues, or wood waste, to supply part of its own energy needs. Wood waste accounts for about 1.7 per cent of Ontario's total energy needs. Some wood is also burned for home heating. The total amount used for this purpose is relatively small, but growing rapidly.

The energy picture for Canada is rather different from Ontario's (Figure 2). Crude oil meets about 37 per cent of Canada's needs, natural gas 19 per cent, and coal 10 per cent. Water-power provides about one-quarter of Canada's energy requirements, twice the proportion in Ontario. Although uranium is a major source of energy in Ontario, its Canada-wide share is only about five per cent. Most of the uranium consumed in Canada is used to generate electricity in Ontario.

Ontario's energy supplies are obtained mainly from other provinces (Figure 3). About one-quarter is produced within the province, mainly electricity generated from water-power and uranium. Only small amounts of oil and natural gas are produced in Ontario.

As well, Ontario exports electricity and heavy fuel oil to the United States, equivalent to about eight per cent of the province's energy requirements.

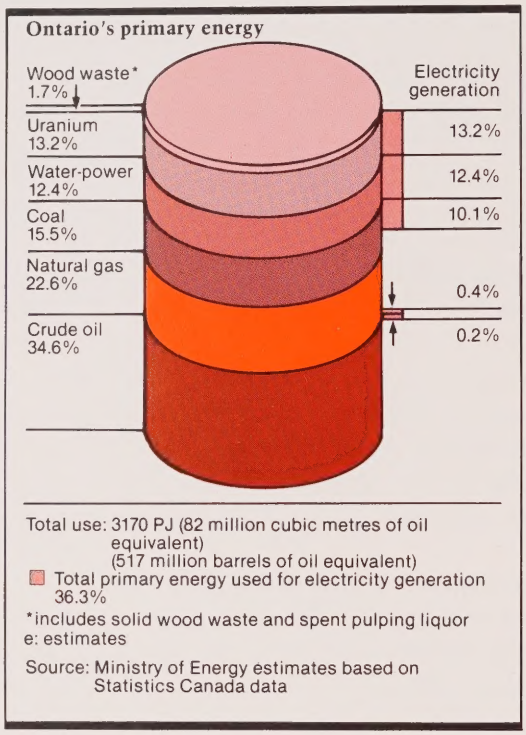
In recent years Canadians have been the largest energy users among industrialized nations (Figure 4). In 1981, Canadians used approximately 17 per cent more energy than Americans and almost twice as much as Swedes on a per capita basis. Canadian energy use per capita was 414 gigajoules (GJ) in 1981, equivalent to 10.7 cubic metres (67.3 barrels) of oil.

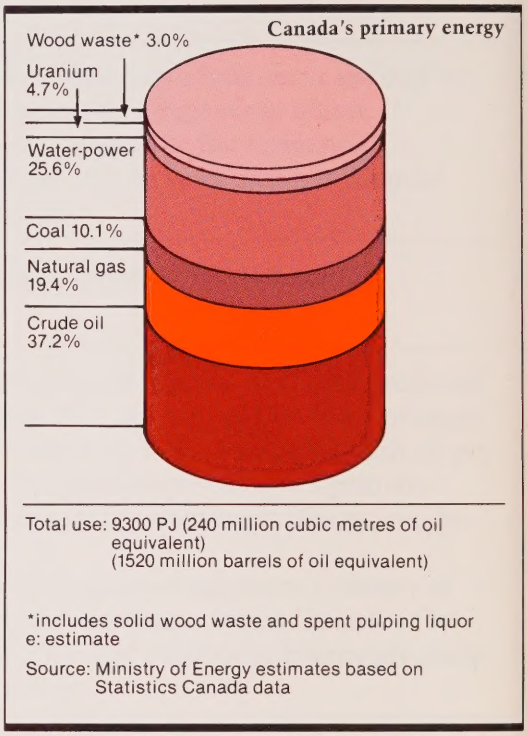
A cold climate, long distances, a resource-based, industrial economy and a high standard of living help account for Canada's higher rate. Also, most other industrialized countries have faced higher energy prices than Canada for many years and have adjusted their fuel consumption habits accordingly.

Ontario's primary energy use 1982[e]

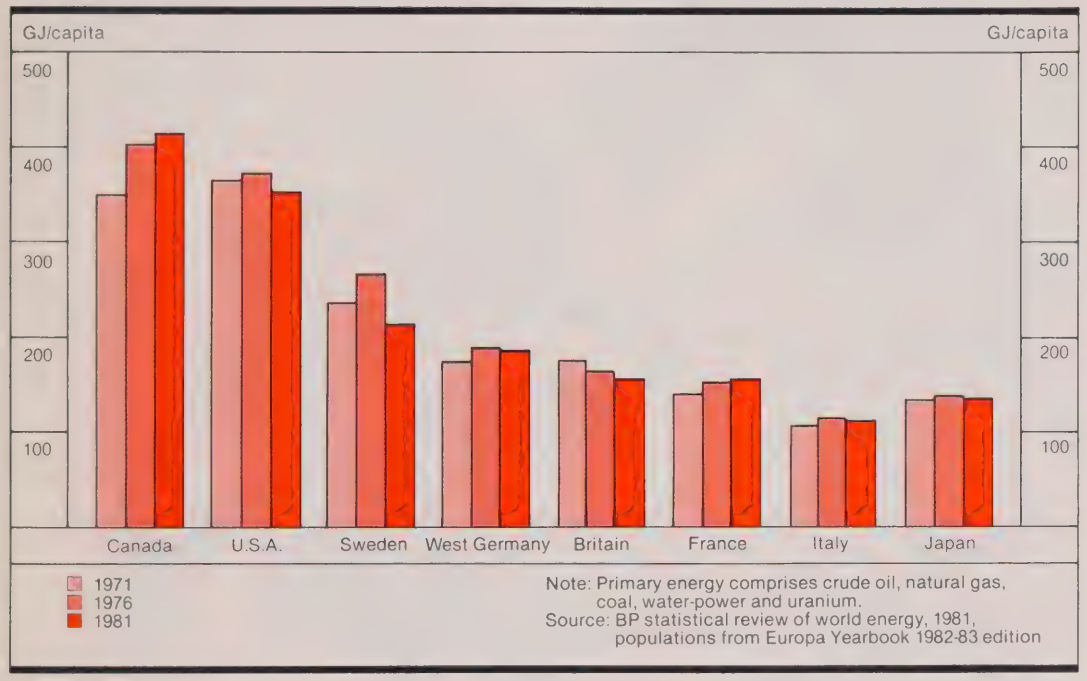
Canada's primary energy use 1982[e]

Figures 1 and 2
Ontario accounts for approximately one-third of Canada's total primary energy use. Oil is the single most important energy source for the province.





Ontario's primary energy sources 1982[e]
Figure 3
Ontario obtains three-quarters of its energy requirements from other provinces and abroad.



Per capita primary energy use for selected countries
Figure 4
Canada uses more energy per capita than do other industrialized nations. International comparisons reflect standards of living, climate, population density, industrial structure and prices.

Oil

World Oil *– World oil prices doubled in 1979-80. The recent drop in prices does not mean oil problems are over.*
Canadian Oil Supply and Demand *– Canada's target is oil self-sufficiency by 1990. Demand has dropped, but production of conventional oil is falling faster.*

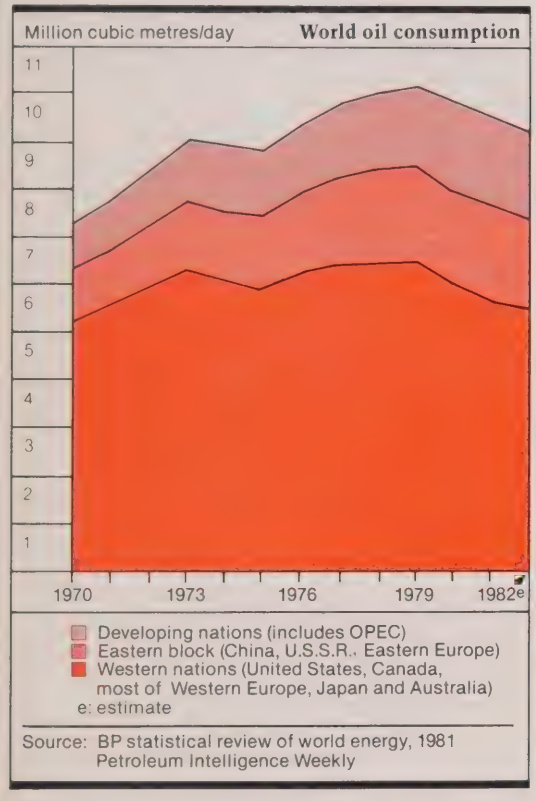
Consumption *– Ontario continues to move off-oil. In 1982 alone, demand for oil dropped 11 per cent.*

World oil situation

The world oil situation has changed dramatically since the 1979 Iranian revolution triggered oil shortages that caused world oil prices to rise from about $13 U.S. per barrel ($82 U.S. per cubic metre (m^3)) in 1979 to U.S. $33/barrel (U.S. $207/$m^3$) by mid-1982.

The Organization of Petroleum Exporting Countries (OPEC) has been the largest single source of international oil supplies for years. However, the proportion of production under its control has diminished in recent years with the emergence of important new sources, primarily in the North Sea and Mexico. These extra supplies, coupled with declining demand for oil, have created an over-supply on the market. This situation has persisted in spite of the Iran-Iraq war which removed a significant share of OPEC production from world trade.

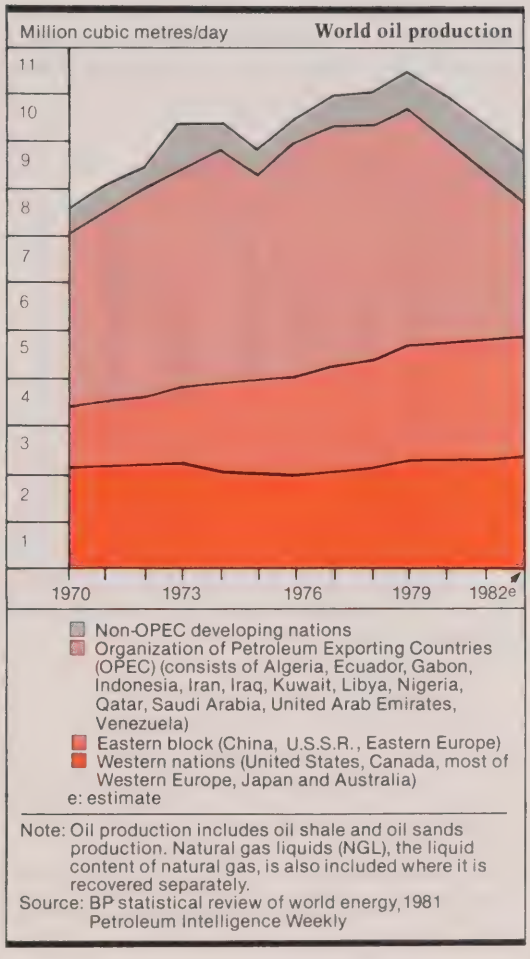
Between 1979 and 1981, the world demand for oil decreased about seven per cent (Figure 5). A further decline of six per cent occurred in 1982 in industrialized countries as a result of the international recession, growing conservation efforts, and a greater use of non-petroleum sources of energy. Despite the declining demand, oil remains the world's single most important fuel. In 1981, it supplied 41 per cent of global energy needs.



The world oil surplus was almost 320 000 m^3 a day in early 1982. This was less than four per cent of the world's total oil consumption but it was enough to create a buyers' market. Consequently, oil that was priced as high as U.S. $36/barrel (U.S. $226/$m^3$) (the weighted average international price) in January, 1981 fell to U.S. $33/barrel (U.S. $207/$m^3$) in July, 1982. Downward pressure on prices persisted into 1983, as several OPEC nations sought to produce more than their targets set by the cartel.

Since the first oil price shock in 1973/74, when OPEC quadrupled its prices, world oil demand has increased only about 0.5 per cent per year, compared with seven per cent per year from 1970 to 1973. In the Western nations, the demand for oil has decreased by an average 1.4 per cent per year since 1973, compared with an average annual growth of 6.5 per cent from 1970 to 1973. The growth in world oil demand since 1973 has been due primarily to increased oil needs in developing nations.

Despite recent demand and supply shifts, the world oil market has retained its fundamental characteristics over the past decade (Figures 5 and 6). The Western industrial nations and Japan continue to account for most of the world's oil consumption, but for only a small share of world oil production. In 1982, their oil requirements – about 5.4 million m^3/day – were about 59 per cent of the world's requirements, while their production – about 2.5 million m^3 daily – accounted for 28 per cent of all oil produced.

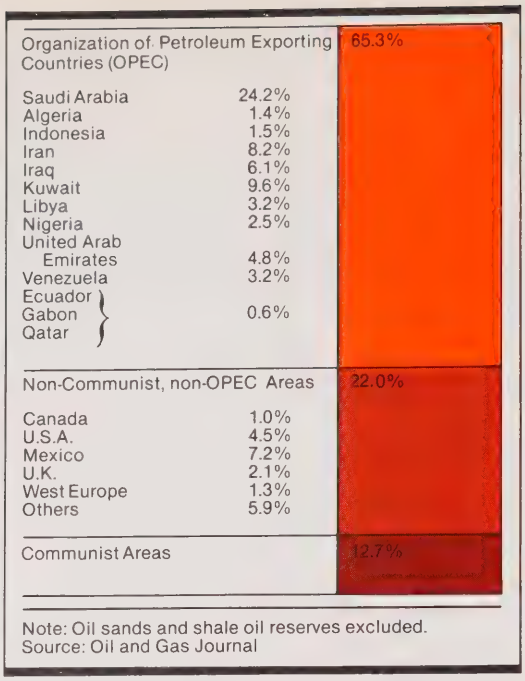


World oil consumption
World oil production
Figures 5 and 6
The western industrialized nations consume six-tenths but produce only a quarter of the world's oil. OPEC remains the largest supplier in the world oil market.

OPEC nations have enormous reserves of oil. The world's proven oil reserves, excluding oil sands and oil shales, were an estimated 107 billion m^3 at the beginning of 1983, the equivalent of a 31-year supply based on 1981 production levels. The OPEC nations have about 65 per cent of these reserves (Figure 7).

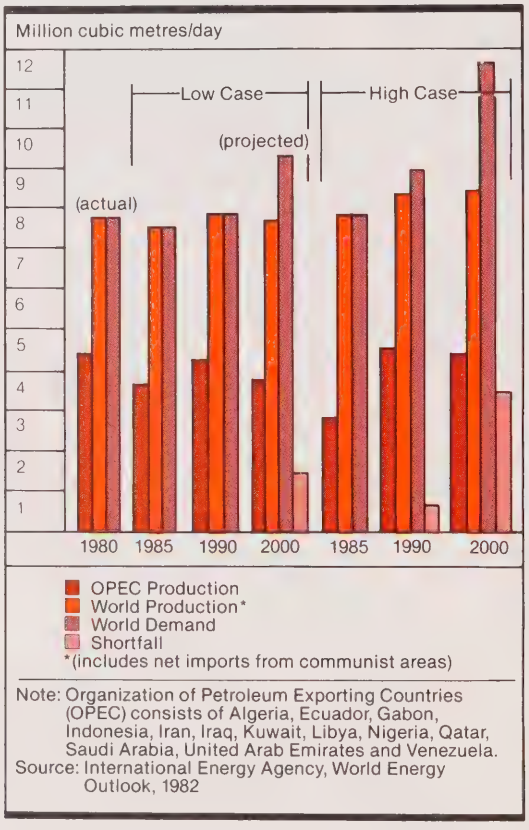
Over the long term, oil will remain a scarce and expensive commodity, because of declining

Proven world crude oil reserves as estimated at January 1, 1983 107 billion cubic metres (670 billion barrels)
Figure 7
Members of OPEC have approximately two-thirds of the world's proven crude oil reserves.



Note: Oil sands and shale oil reserves excluded.
Source: Oil and Gas Journal

Non-communist oil supply and demand 1980 - 2000
Figure 8
The International Energy Agency cautions that oil short-falls could occur in the 1990s.



Note: Organization of Petroleum Exporting Countries (OPEC) consists of Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela.
Source: International Energy Agency, World Energy Outlook, 1982

world reserves, increasing costs of new supplies and growing demand from the world's developing nations. Recent projections prepared by the International Energy Agency (IEA) point to a possible shortfall in the range of 16 to 28 per cent by the turn of the century (Figure 8). These projections assume political stability in exporting countries.

The Middle East accounts for about two-thirds of OPEC's production and more than 60 per cent of the crude oil moving in international trade. As long as the world depends on oil from the Middle East, conflicts in this area will create difficulties in international energy markets.

If international oil supplies are disrupted, depending on the severity, extent and duration, Canada could be significantly affected under the terms of the IEA. Canada belongs to the IEA, a 21-member group of western, industrial countries and Japan that have agreed to share oil supplies should there be a shortfall. It was established in 1974 following the Arab oil embargo.

Canadian oil supply and demand

Canada is moving toward self-sufficiency in oil. In 1982, Canada's net imports amounted to 20 000 cubic metres (m^3) per day, or about eight per cent of its oil requirements. In the previous two years, Canada relied on foreign sources for about 20 per cent of its supplies.

When the federal government introduced its National Energy Program in October, 1980, it set a target of achieving national self-sufficiency in oil by 1990. It identified the need for increased domestic oil supply and for continued conservation and substitution efforts.

Between 1980 and 1982, oil consumption dropped 16 per cent. Canada's demand for oil is expected to decline about one per cent a year between 1982 and 1990, according to projections made by the federal government in mid-1982. This would make self-sufficiency possible by 1990 (Figure 9).

As for supply, Canada's conventional oil reserves, located primarily in Western Canada, continue to decline. At the end of 1981, Canada had economically recoverable reserves of 715 million m^3 of conventional oil. This represents about a 10-year supply, based on 1982 production levels. Production from established conventional reserves in Western Canada averaged 195 000 m^3 per day in 1982. The federal government expects this to decline to 135 000 m^3 per day in 1985 and 84 000 m^3 per day by 1990.

New discoveries of oil in Western Canada and improved techniques for extraction from known reservoirs are expected to increase the availability of oil in the future. However, these two sources of additional supply are unlikely to compensate fully for the decline in conventional oil production.

Canada also has vast oil resources in the oil sands regions of Western Canada and in the frontier areas (the Arctic, the Mackenzie Delta, the Beaufort Sea and off the east coast) (Figure 10). Only Hibernia, off the east coast, has been developed to the point where production can be expected by 1990.

The timing and rate of production from these frontier and oil sands resources is uncertain because of high interest rates, downward pressures on world oil prices, and environmental and technical considerations.

Two oil sands plants are now in production at Fort McMurray, Alberta. The Suncor installation came on stream in 1967, and the Syncrude project in 1978. Together, these projects produced almost 22 300 m^3 of oil daily in 1982, about 10 per cent of the country's total oil production.

Two other major oil supply projects, Cold Lake and Alsands, were postponed in 1981 and 1982 respectively.

The Alberta Energy Resources Conservation Board (AERCB) estimated that, at the end of 1981, 3.9 billion m^3 of synthetic crude oil could be recovered by surface mining from established reserves in the oil sands regions. This is about 5.5 times the size of the country's remaining recoverable supply from conventional areas. The AERCB also estimated that up to 30 billion m^3 of synthetic oil could be recovered with improved mining and recovery technologies.

The recession and energy conservation have dramatically reduced Canada's consumption and consequently, its imports of crude oil. In the long run, however, the country is expected to increase its dependence on imported oil when the economy improves.

Oil in Ontario

Consumption Ontario has cut its demand for oil significantly in recent years. Between 1979 and 1981 alone, Ontario's total oil consumption dropped about 10 per cent. This decline was slightly more than the nine per cent reduction for Canada as a whole and well above the seven per cent drop in world demand. During 1982, Ontario's estimated oil consumption declined a further 11 per cent.

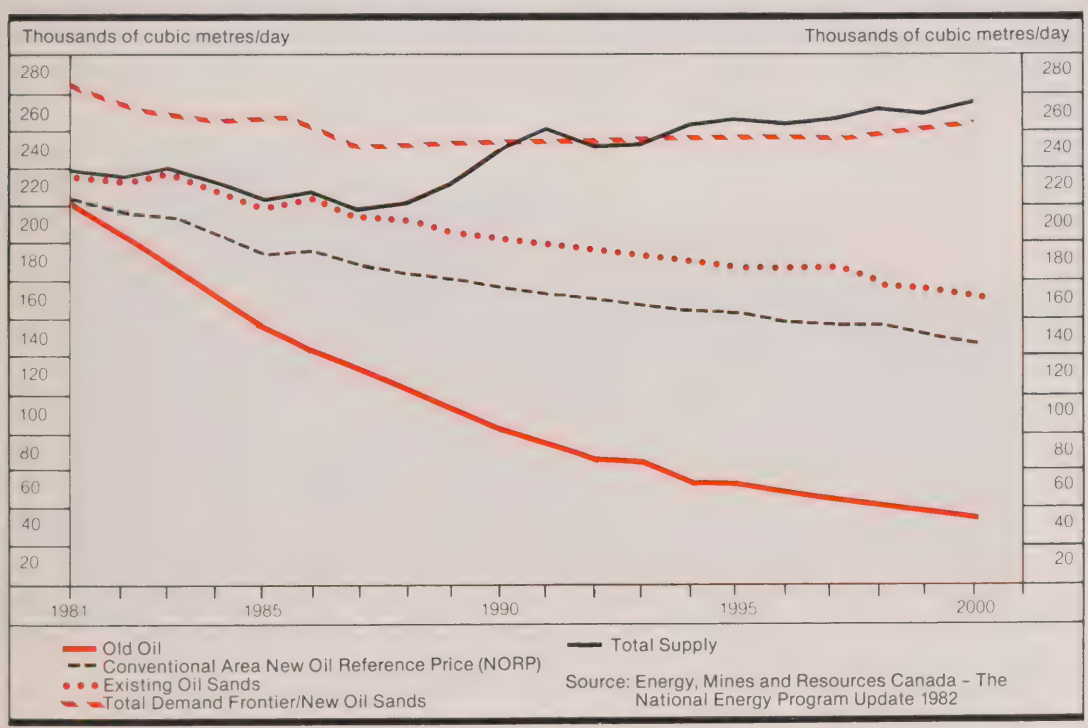
This reduction in Ontario's oil demand arose partially from weakness in the economy. Also, consumers have been choosing less expensive and more secure alternatives to oil. In the 31 months prior to April, 1983, about 159 300 homeowners converted their heating systems from oil to natural gas, electricity, wood and other fuels.

Between 1975 and 1982, oil's share of Ontario's primary energy use fell from 40 per cent to 35 per cent. Despite this drop, oil remains the single most important source of energy in Ontario.

Oil consumption in Ontario in 1982 was 77 960 cubic metres (m^3) daily. Oil is consumed by vehicles, in residences, and in the operation of industrial and commercial enterprises. It is also used to produce non-energy products (oil-based goods including plastics, nylon, lubricating oil and waxes) and to operate the refineries themselves (Figure 11). Ontario's only oil-fired generating station, Lennox near Kingston, was mothballed in 1982.

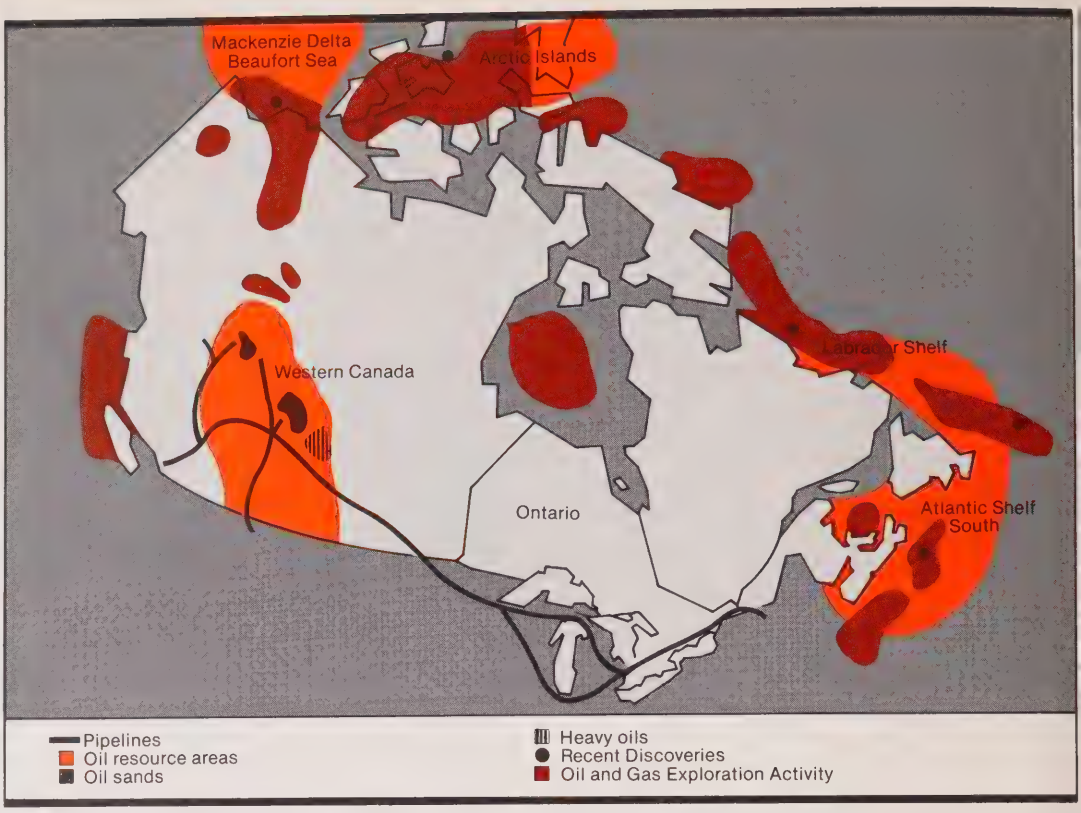
Supply to Ontario Over 90 per cent of the oil Ontario consumes comes from Western Canada via the Interprovincial PipeLine system (Figure 12). Most of the rest is U.S. crude oil obtained on an exchange basis to reduce east-west transportation costs. In 1981, Ontario imported about 84 000 m^3 of oil – representing about 0.3 per cent of the province's requirements – from outside North America. This oil replaced supplies lost when the Government of Alberta cut back its production as part of its strategy for dealing with the federal government on prices and revenue-sharing. This temporary situation was resolved by the Canada-Alberta Agreement in the fall of 1981.

Ontario produces about three-tenths of one per cent of the oil it consumes. The first commercial oil well in North America was established near Sarnia, at Oil Springs, in 1858. The Ontario Energy Corporation (OEC) is exploring for oil and gas near this area of southwestern Ontario. The province also has oil shale deposits in the Great Lakes area of southern Ontario and in the James Bay lowlands in northern Ontario. The OEC and the Ontario Ministry of Natural Resources are analyzing these deposits to determine whether

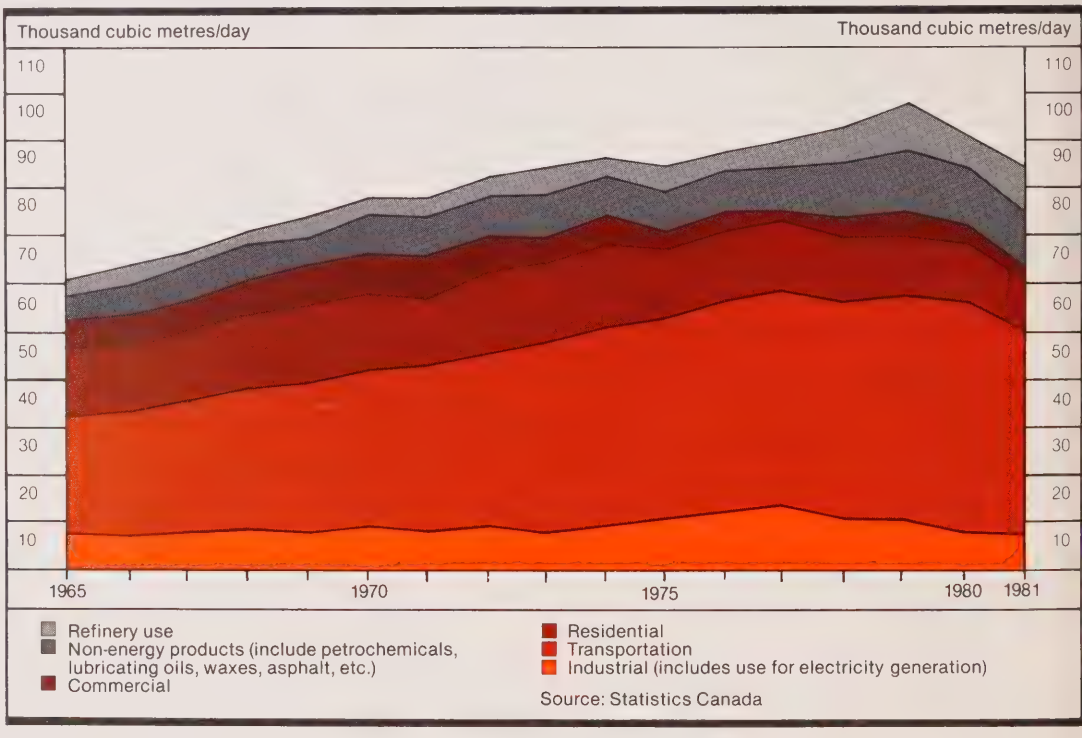


Canadian oil supply and demand projection
Figure 9
Canada has the potential for oil self-sufficiency in the 1990s.

Major oil pipelines and oil fields in Canada
Figure 10
Currently, Western Canada is the principal source of domestic oil supply. Offshore areas could become significant in future years.



Oil consumption in Ontario
Figure 11
Ontario has been using less oil since 1979. One out of every two barrels consumed is required for transportation purposes.



the oil can be recovered economically.

The Government of Ontario established the OEC in 1974 to invest in Canadian energy projects in order to increase the province's energy security. Its initial investments were in the Polar Gas project (see natural gas section) and in the Syncrude oil sands project (see Canadian oil section). In 1981, the OEC purchased 25 per cent of the shares of Suncor Inc. from Sun Oil Company Inc. of Radnor, Pennsylvania. The purchase contributes to the Canadianization of the petroleum industry. It will also help contribute to the national goal of crude oil self-sufficiency through the exploration and development of additional reserves.

Suncor (one of Canada's largest oil companies) explores for and produces conventional crude oil and natural gas in Canada's western provinces, and is active in the Arctic and offshore Labrador. The company was the first to tap the Alberta oil sands on a commercial scale. Suncor also owns and operates a refinery in Sarnia. As well, Suncor distributes and markets gasoline (under the Sunoco name), petrochemicals, home heating oil, heavy fuel oil, lubricants and specialty products.

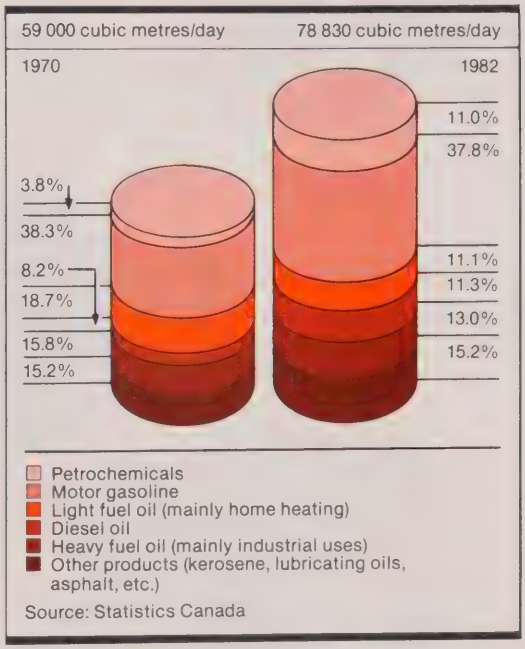
Ontario's oil pipeline system
Figure 12
Virtually all of Ontario's oil supply is transported via the Interprovincial PipeLine system from Western Canada to refineries in Sarnia and the Toronto region.

In September, 1982, the OEC and Suncor announced the formation of Trillium Exploration Corporation to carry out oil exploration programs on Canadian frontier lands held by Suncor and other firms. Trillium Exploration Corporation qualifies for maximum exploration grants from the federal government because it is 75 per cent Canadian-owned. Under the National Energy Program, any exploration group which is 67 per cent Canadian-owned will receive 80 cents for every dollar spent on exploring those frontier areas (identified as "Canada lands") from the federal government. The exploration grants are called Petroleum Incentive Payments.

Ontario currently has no access to oil pipelines from the east. The pipeline from Sarnia to Montreal accommodates only an easterly flow of crude oil. If the flow were reversed, the pipeline from Portland, Maine to Montreal could probably handle at least 20 per cent of Ontario's crude oil needs without expansion. This pipeline may be used in the future to transport oil produced off the coast of Newfoundland.

Refineries in Ontario The main petroleum products produced by Ontario's eight refineries are shown in Figure 13. Gasoline accounts for more than one-third of the production, while light fuel oil and petrochemicals each constitute about 11 per cent. Most of the province's refinery capacity is at Sarnia, and the rest is in the Oakville-Mississauga area west of Toronto and at Nanticoke on Lake Erie.

Ontario's refineries produce about 90 per cent of the refined oil needed in the province. The other 10 per cent is delivered to eastern Ontario from Montreal to minimize transportation costs. The refineries also produce some oil products for other provinces and for export.



Ontario refinery production
Figure 13
Gasoline is still the major refinery product but petrochemical production has increased significantly.

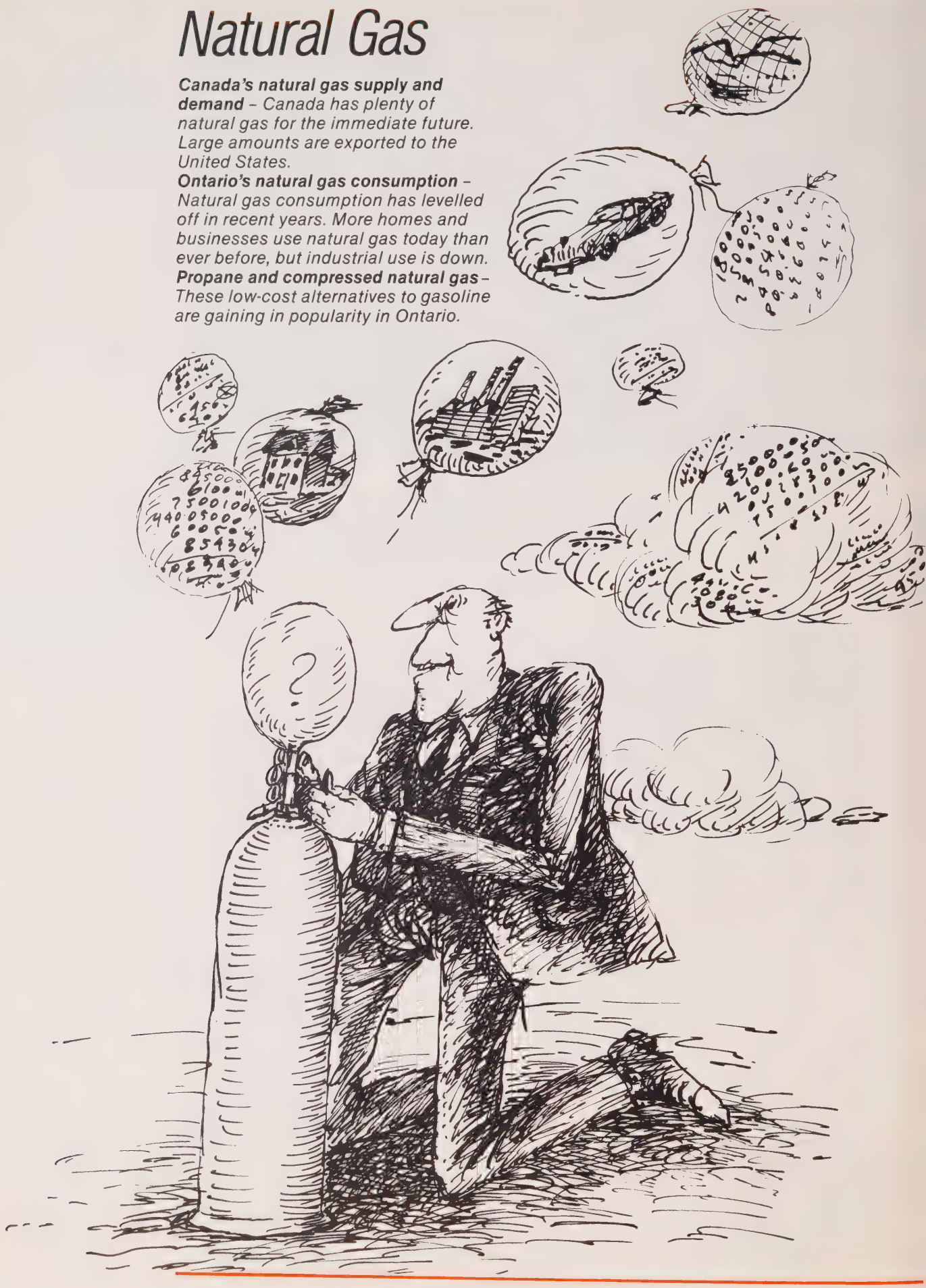
Ontario's refineries currently operate at about 70 per cent capacity, which represents a marginally efficient economic operating level. The refineries face major adjustments in the 1980s and 1990s when a higher ratio of gasoline to heavy fuel oil and heating oil will be required to accommodate reductions in demand for these latter two products. Suncor, for one, has announced a $335 million program to expand its capacity to upgrade crude oil at its Sarnia refinery by 1984.

Natural Gas

Canada's natural gas supply and demand – *Canada has plenty of natural gas for the immediate future. Large amounts are exported to the United States.*

Ontario's natural gas consumption – *Natural gas consumption has levelled off in recent years. More homes and businesses use natural gas today than ever before, but industrial use is down.*

Propane and compressed natural gas – *These low-cost alternatives to gasoline are gaining in popularity in Ontario.*



World natural gas

The world natural gas picture is important to Ontario because the amount of gas Canada exports may affect our future supply and prices.

The global demand for natural gas continues to grow. Between 1971 and 1981, world demand for natural gas increased nearly 35 per cent. Natural gas supplied about one-fifth of global energy needs in 1981 compared with a 41 per cent share for oil and 30 per cent for coal.

The United States, western European nations and Japan are the major importers of natural gas (Figure 14). On the other hand, countries such as Canada, Mexico and the Soviet Union produce more gas than they use, and export the surplus. By 1984, Western Europe is expected to get some of its natural gas through the pipeline from Siberia, which is currently under construction.

There is an abundant world supply of natural gas. Between 1967 and 1979, about four times more gas was discovered than was produced. At the end of 1981, the total world proven gas reserves were an estimated 82.4 trillion cubic metres (Figure 15). This would last 53 years at 1981 world production levels.

Canada's natural gas supply and demand

Canada has an abundant supply of natural gas. At present, about one-third of the natural gas produced in Canada is exported to the United States.

Canada has natural gas deposits in Alberta, British Columbia, Saskatchewan, the southern Yukon and Northwest Territories, the Mackenzie Delta, Beaufort Sea, Arctic Islands, the Sable Island area off the east coast, and, to a small extent, Ontario. The country's major natural gas resources are shown in Figure 16. Canada's total proven reserves were an estimated 2.1 trillion cubic metres (m^3) at the end of 1981. Based on 1982 production rates, this amount could last 30 years. As further discoveries are made in conventional and frontier areas, the country's known resources could increase significantly.

Possible delivery routes for these resources to southern markets appear in Figure 16. The Ontario Energy Corporation (OEC), Petro-Canada and some private companies are partners in the Polar Gas Project, a proposal to deliver gas from the Mackenzie Delta/Beaufort Sea and Arctic Islands areas to southern markets.

Total Canadian production of marketable natural gas in 1982 was 69 billion m^3. In Canada, net sales of natural gas during 1982 increased by about two per cent, due primarily to conversions from oil. Also, exports to the United States rose by 2.8 per cent in 1982 over 1981 – to 22.2 billion m^3. Despite this, export levels were well below those authorized by the National Energy Board (NEB). Increased natural gas discoveries in the United States, a general slowdown in the American economy, and the relatively high export price of Canadian gas combined to restrain export sales.

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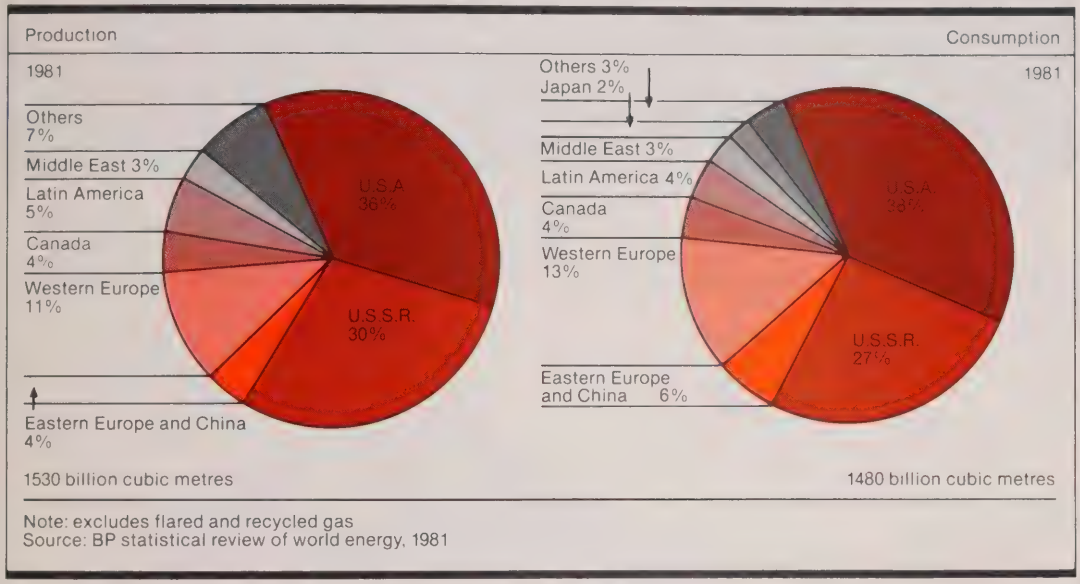

World natural gas production and consumption
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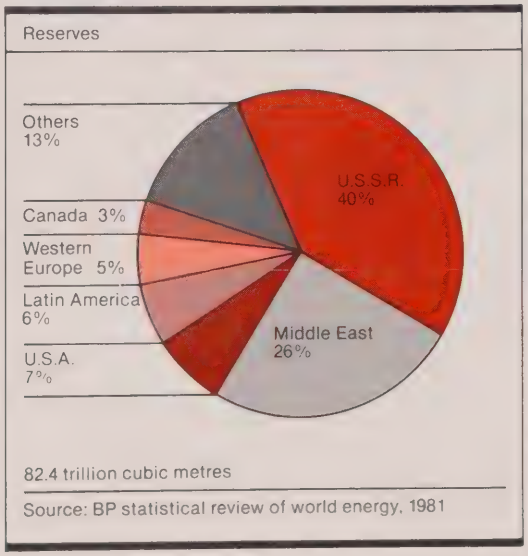
Canada, USSR, Mexico and Algeria are major exporters of natural gas.



World proven natural gas reserves at end 1981
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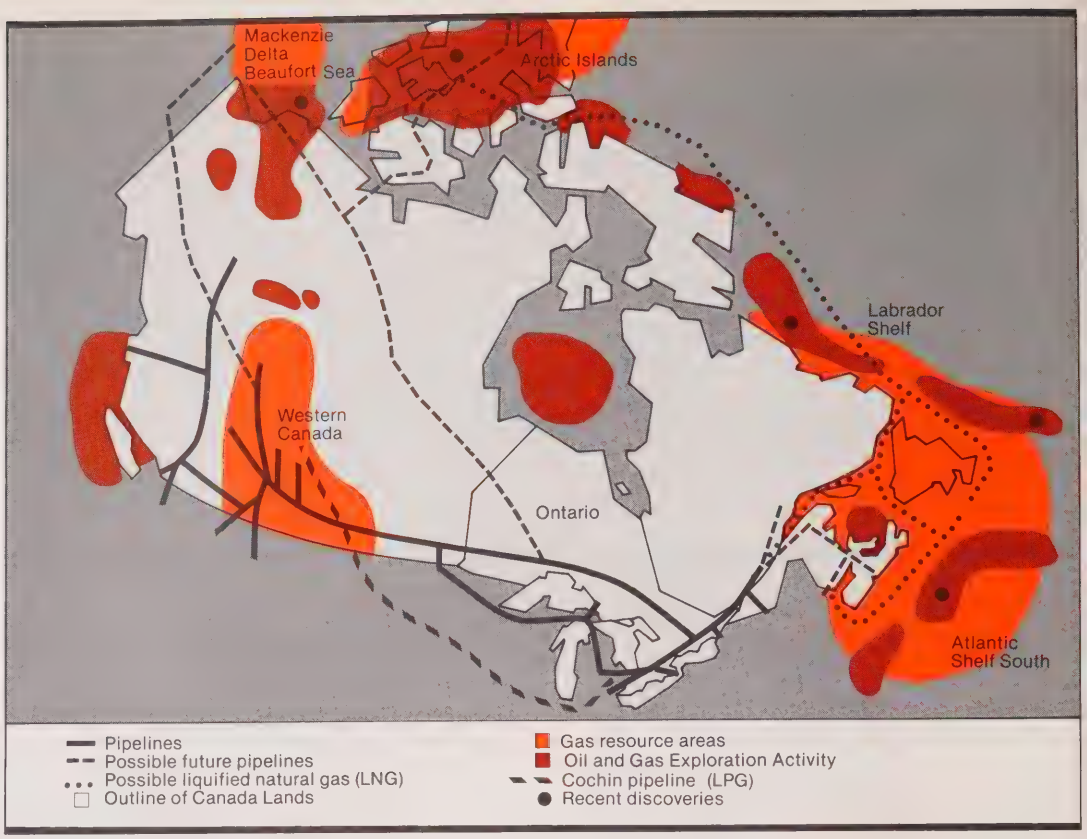
Only one-seventh of the world's natural gas reserves are located in North America compared to more than one-third in the Soviet Union.



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Ontario's natural gas consumption

Natural gas meets more than one-fifth of Ontario's primary energy requirements, second only to oil which supplies more than one-third.

Ontario used nearly three times as much natural gas in 1982 as it did in 1965. The province's gas consumption grew rapidly from about seven billion cubic metres (m^3) in 1965 to a high of nearly 20 billion m^3 in 1976 (Figure 18). Since then, annual consumption has stayed relatively constant at about 19 billion m^3.

The industrial sector accounts for almost half of Ontario's natural gas consumption. Although the use of natural gas in industries grew steadily from 1965 to the mid-1970s, consumption dropped nearly 13 per cent between 1976 and 1981. Competition from heavy fuel oil, used mainly for industrial processes, has been a major reason for the drop in demand for natural gas in this sector. Also, Ontario Hydro has almost eliminated its use of natural gas for electricity generation, although Ontario Hydro accounted for about 15 per cent of the industrial natural gas consumption in 1975.

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Virtually all the natural gas Ontario uses comes from Western Canada, mainly Alberta (Figure 19). Although imports from the United States represented almost one-quarter of Ontario's supply in 1968, they were phased out by 1977.

Natural gas is piped to underground storage pools in southwestern Ontario in the warmer months, when demand is lower than average. The province's total storage capacity is 3.9 billion cubic metres (m^3), about a two-month supply. Such storage capacity provides security of supply in emergencies. It also allows distributors to purchase gas from TransCanada PipeLines year-round at an almost constant rate and yet meet the sharp peak demands of the winter heating season.

Propane and compressed natural gas

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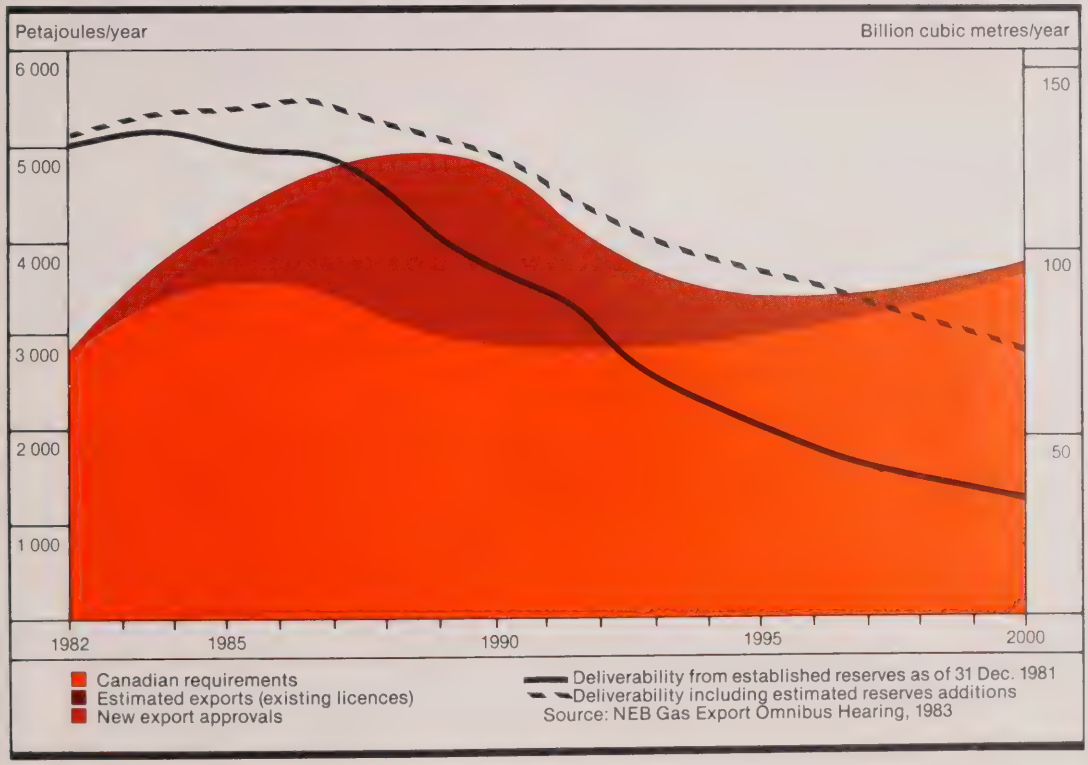
Propane is available at about 1000 re-fuelling stations across the province, and is becoming an increasingly popular, low-cost alternative to gasoline. To encourage conversions, the Ontario government has exempted propane and other non-petroleum fuels from the motor fuel taxes since 1980. Further, new vehicles, powered by propane and non-petroleum fuels and conversion kits, are exempt from provincial retail sales tax. Also, the federal government offers a conversion grant to commercial and farm vehicles fuelled by propane.



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The National Energy Board expects Canada to have an abundant natural gas supply over the next decade. The federal government has accepted the board's recommendation to double authorized exports.

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Approximately 2.3 million m^3 of propane were delivered to or made in Ontario in 1982. About three-quarters came from other provinces, primarily Alberta (Figure 21). The rest was produced as a by-product of the oil refining process at Ontario refineries. About 56

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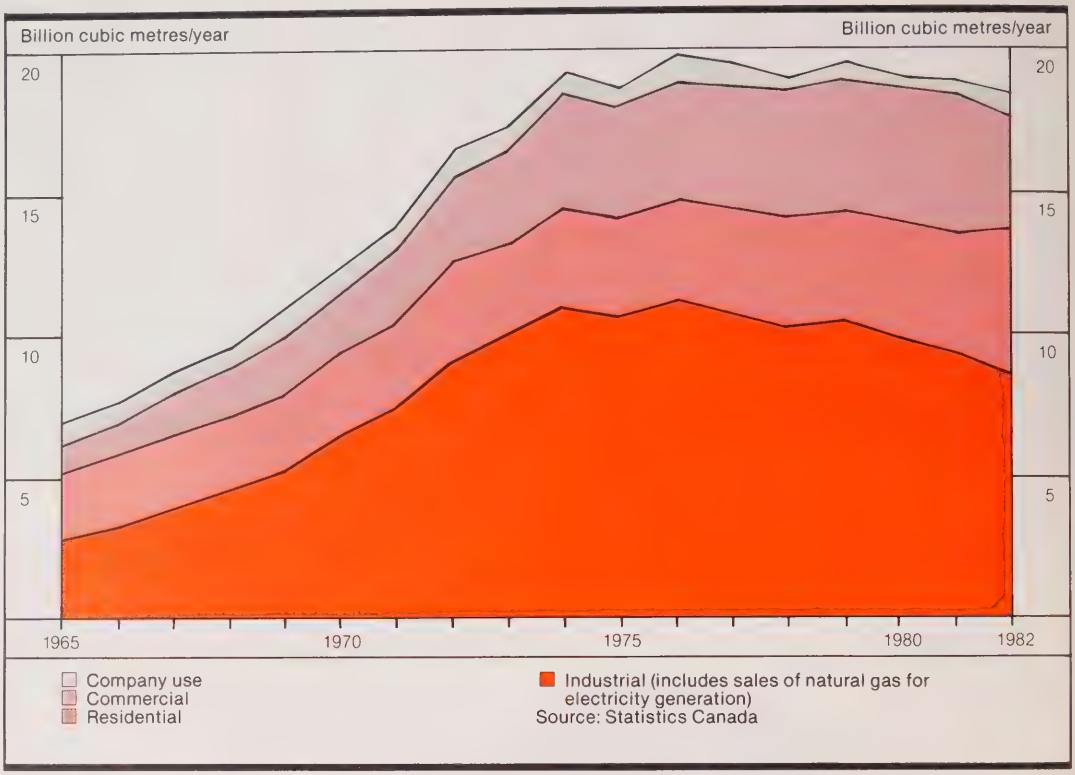

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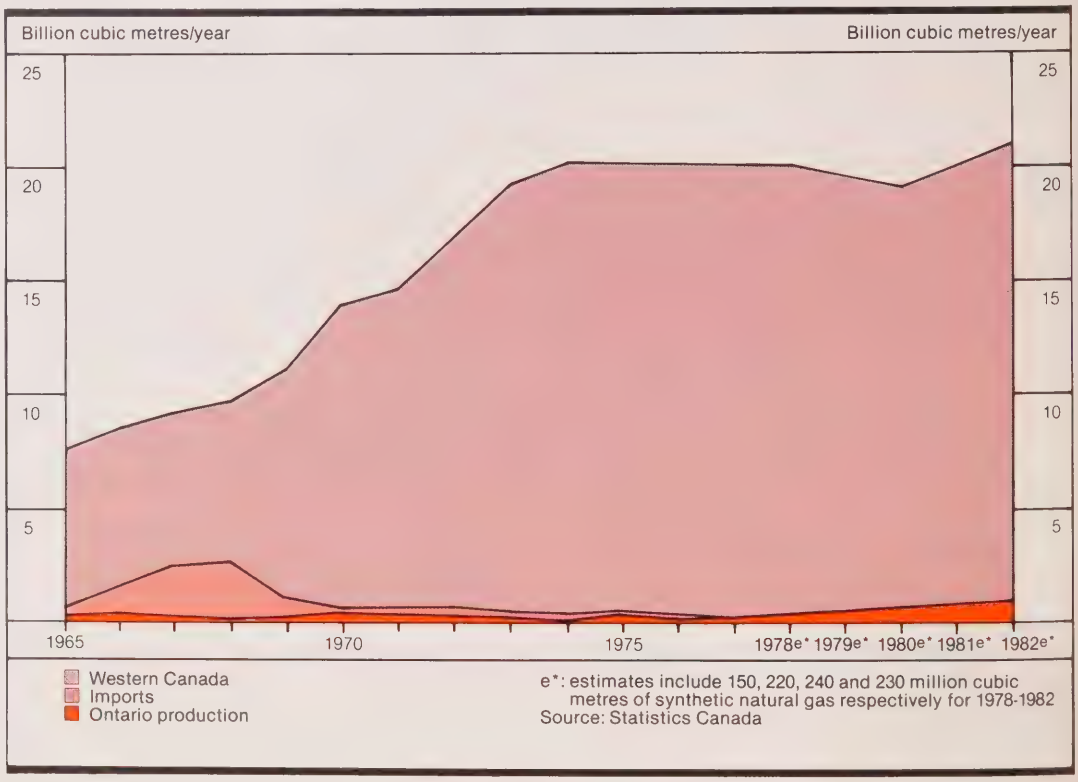
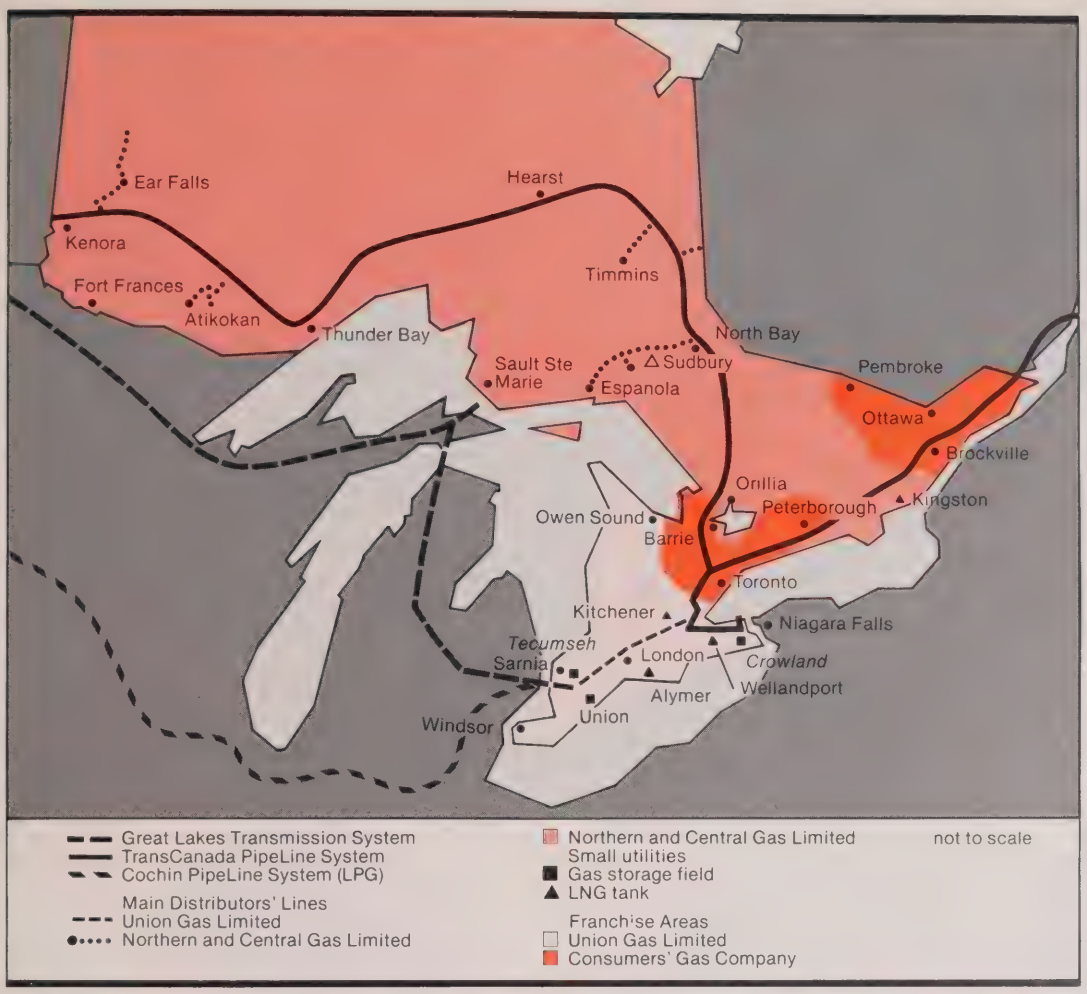
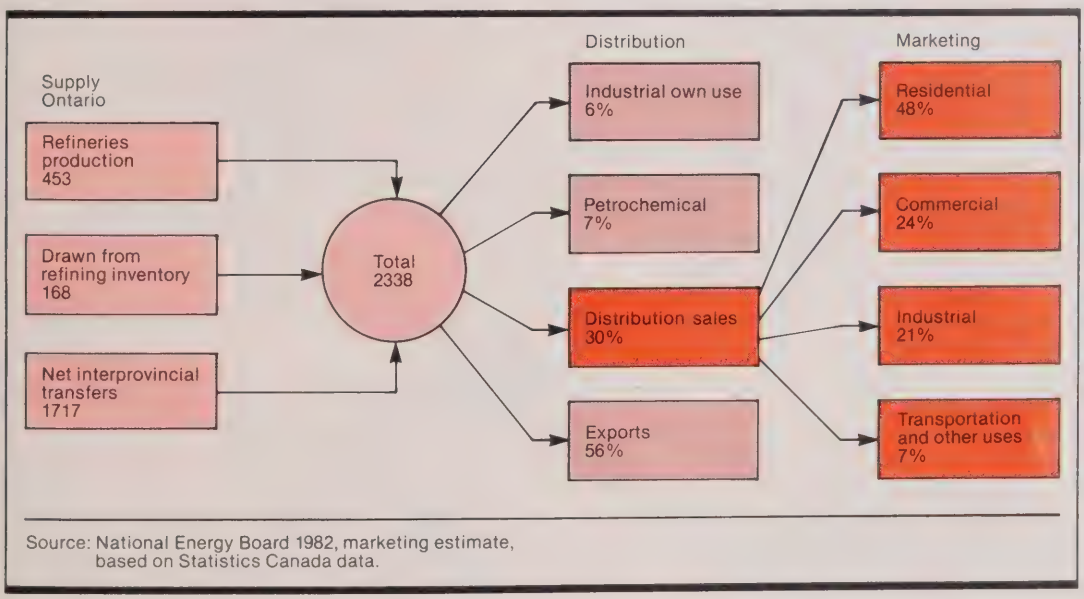
Almost all of the natural gas used in Ontario originates in Alberta. Imports of natural gas from the United States were phased out by 1977.





Natural gas pipelines in Ontario
Figure 20
The TransCanada PipeLine and Great Lakes Transmission systems transport natural gas from Western Canada to Ontario. It is widely distributed within the province.



Source: National Energy Board 1982, marketing estimate, based on Statistics Canada data.

Propane supply and demand in Ontario, 1982 (thousand cubic metres)
Figure 21
Propane is used in Ontario primarily as a petrochemical feedstock, for industrial purposes and for space heating. Its use as a transportation fuel is growing rapidly.

Coal

Canadian coal supply and demand – *Canada has vast reserves of coal, and demand is growing, but slowly.*
Ontario's coal consumption – *Ontario Hydro and Ontario's steel industries together consume about half of the coal needed in Canada each year.*
Peat and lignite – *Ontario has significant peat and lignite deposits.*

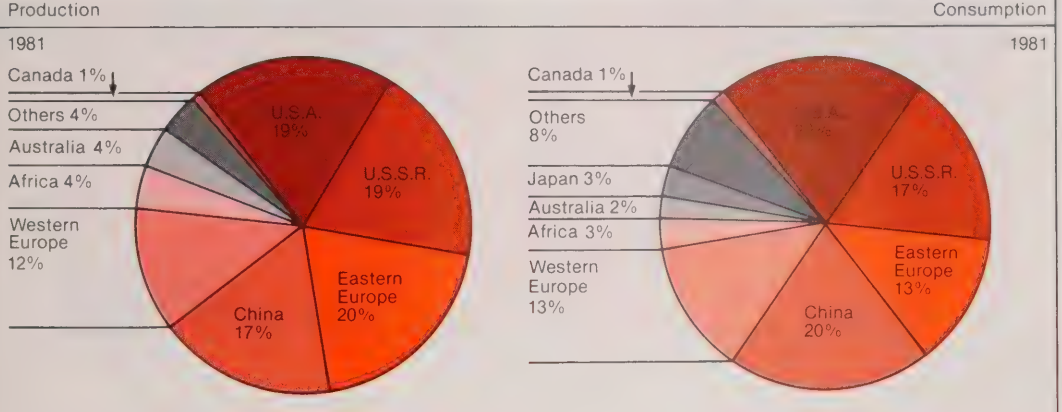
World coal

Coal dominated the world energy scene until the 1950s. In 1950, it supplied 60 per cent of the world's energy needs. Since then, its share has declined steadily to 30 per cent in 1981.

The importance of coal will likely increase in the world energy market. In the past decade, production has risen by about 30 per cent, as a result of sharp price escalation for oil in the 1970s and uncertainties over oil prices and supply. Most of this increased production was used for steel production and electricity generation.

The world's major coal producers are the United States and the Soviet Union, each with production in excess of 700 million tonnes in 1981, and China with approximately 655 million tonnes. Together these three countries accounted for about 55 per cent of both world coal production and consumption (Figure 22).

World coal production should more than double by the year 2000, according to the World Coal Study released in 1981 by the Massachusettes Institute of Technology.



World coal production and consumption
Figure 22
The world supply and demand picture for coal is completely different from that of oil – the large coal consuming countries are also the dominant producers.

The world has abundant coal resources. They have been estimated at more than 10 000 billion tonnes. Less than 16 per cent of the currently estimated recoverable reserves of 663 billion tonnes (Figure 23) would be consumed by the year 2000, according to the World Coal Study. This represents only about one per cent of the estimated total resources.

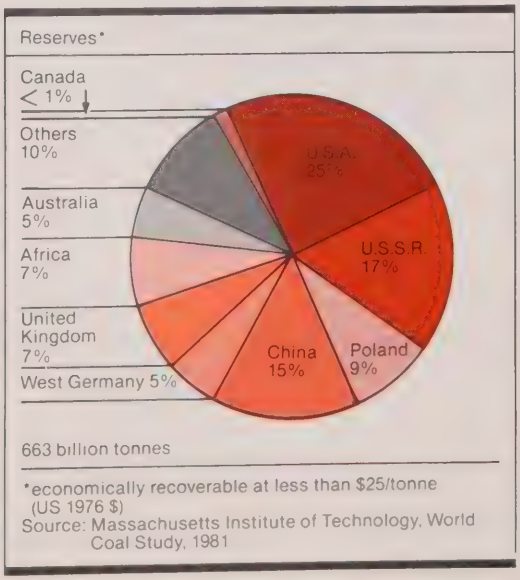
Canada's coal supply and demand

Canada accounts for about one per cent of total world production and consumption of coal. The country has 475 billion tonnes of coal, including lignite. Of this amount, the National Energy Board (NEB) estimated, in 1981, that 5.9 billion tonnes (equivalent to a 147-year supply based on 1981 production rates) can be recovered economically with today's technology. More than 95 per cent of the country's known coal resources are in British Columbia, Alberta and Saskatchewan. The rest is in Eastern Canada, primarily in New Brunswick and Nova Scotia.

Despite Canada's significant coal resources, the country has been a net importer of coal. Transportation costs have a major influence on coal trade. Coal from Western Canada costs up to 50 per cent more in Ontario than coal from the United States.

Canada produced 42.8 million tonnes of coal in 1982, more than double the 1970 figure. During this time, Canada's coal exports quadrupled, due largely to Japanese demand for coal for its steel industry. Other major customers include South Korea, western Europe and Brazil. In 1982, exports reached 15.5 million tonnes. However, imports amounted to 16 million tonnes, making Canada a net importer of only 0.5 million tonnes.

Since 1950, Canada's coal consumption has fallen substantially relative to other fuels. In 1982, coal supplied 10 per cent of the country's energy requirements, down from nearly 50 per cent in the 1950s. Despite this decline, the demand for coal has increased in absolute



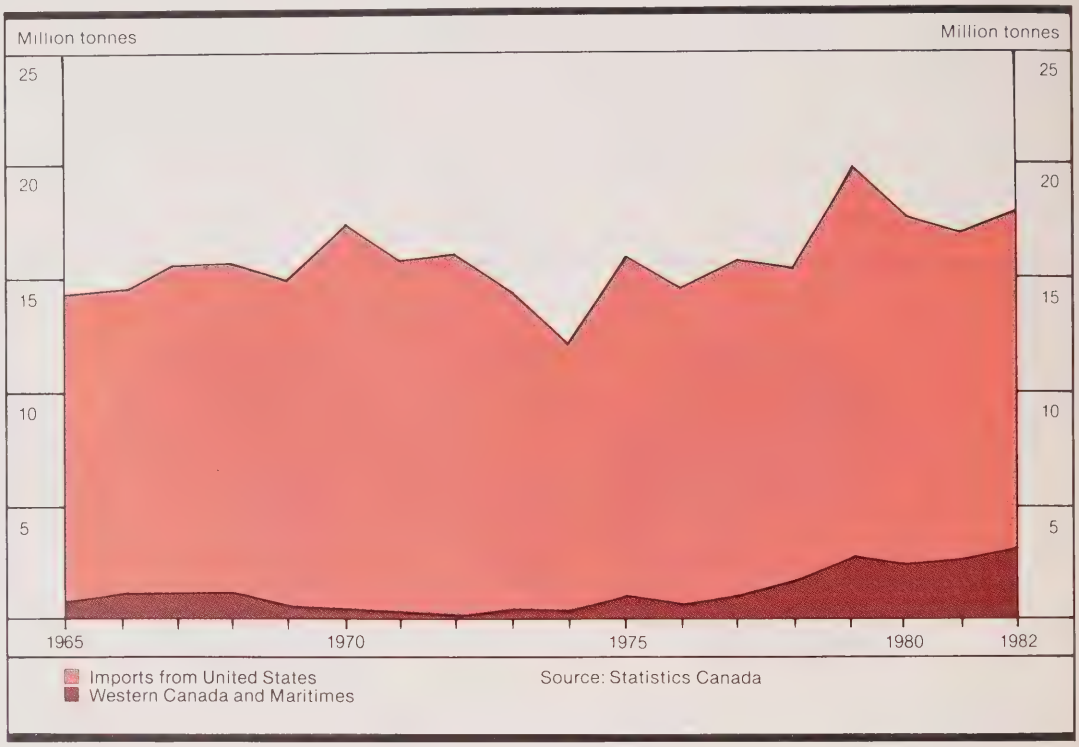
Proven world coal reserves*
Figure 23
The world's coal reserves are widely distributed geographically. Despite Canada's small share of the total, the country has enough to meet its needs for more than a century.

terms, mainly in the last six years. Total consumption in 1982 was 41.2 million tonnes, or 47 per cent above the 1970 level.

About three-quarters of the coal consumed today is used to generate electricity. Coal-fired generation provides about 15 per cent of the electrical power used in Canada. The NEB estimated that the amount of coal needed to generate electricity will more than double by the year 2000, when coal-fired generation is expected to produce about one-quarter of Canada's electricity.

Steel manufacturing accounts for almost one-quarter of Canada's coal consumption. Roughly two per cent is used for space and process heating in other industries.

Coal supply in Ontario
Figure 24
Ontario purchases most of its coal supply from the United States. Increasing amounts are obtained from Western Canada and Maritimes.



Ontario's coal consumption

Ontario is a major coal consumer, accounting for 18 million tonnes annually, or roughly half of Canada's total consumption. In 1982, coal met about 16 per cent of Ontario's primary energy needs, down significantly from 22 per cent in 1965.

The province relies heavily on supplies from the United States and other parts of Canada to meet its needs (Figure 24). In 1982, imports from the United States met over three-quarters of Ontario's coal requirements. The remainder came from Western Canada and the Maritimes. While shipping coal from the Maritimes is less expensive than transporting it by rail from the west, production facilities in the Maritimes are limited. Ontario Hydro has expanded its use of western Canadian coal to diversify its supply sources and to obtain low-sulphur grades that can be blended with higher-sulphur, imported coal.

Virtually all the coal consumed in Ontario is used either to generate electricity (64 per cent) or to make steel (33 per cent). The residential, commercial, industrial (other than steel manufacturing) and transportation sectors accounted for only three per cent of total Ontario coal use in 1982, well below their 39 per cent share in 1965 (Figure 25).

The amount of coal used to generate electricity has tripled since 1965. However, the lower life cycle costs of nuclear-fuelled generating stations has reduced the advantages of coal-fired plants. In 1982, coal accounted for about one-third of total generation. The demand for coal from the steel industry varies with the production of automobiles, appliances and construction equipment. The demand for these products has been weak in recent years.

Peat and lignite

Ontario does not have any high quality (bituminous) coal deposits, but it does have an abundant supply of peat and at least one large deposit of lignite. Both could displace oil and coal in certain applications.

Peat is vegetable matter which has decomposed in water and is partly carbonized. It has a lower heat value and a higher moisture content than coal. In Canada, most of the peat comes from swamps; it is commonly known as the soil conditioner peat moss. The more compressed and decomposed lower layers can be burned directly, converted into fuel pellets, processed into methanol and other fuels, or used as a chemical feedstock.

Ontario has about 26 million hectares of peatland. Almost one-third of this supply is south of the permafrost line. It has an energy equivalent of about 4.2 billion cubic metres (m^3) of oil. This is nearly six times the energy available from Canada's established, conventional oil reserves.

World natural gas

The world natural gas picture is important to Ontario because the amount of gas Canada exports may affect our future supply and prices.

The global demand for natural gas continues to grow. Between 1971 and 1981, world demand for natural gas increased nearly 35 per cent. Natural gas supplied about one-fifth of global energy needs in 1981 compared with a 41 per cent share for oil and 30 per cent for coal.

The United States, western European nations and Japan are the major importers of natural gas (Figure 14). On the other hand, countries such as Canada, Mexico and the Soviet Union produce more gas than they use, and export the surplus. By 1984, Western Europe is expected to get some of its natural gas through the pipeline from Siberia, which is currently under construction.

There is an abundant world supply of natural gas. Between 1967 and 1979, about four times more gas was discovered than was produced. At the end of 1981, the total world proven gas reserves were an estimated 82.4 trillion cubic metres (Figure 15). This would last 53 years at 1981 world production levels.

Canada's natural gas supply and demand

Canada has an abundant supply of natural gas. At present, about one-third of the natural gas produced in Canada is exported to the United States.

Canada has natural gas deposits in Alberta, British Columbia, Saskatchewan, the southern Yukon and Northwest Territories, the Mackenzie Delta, Beaufort Sea, Arctic Islands, the Sable Island area off the east coast, and, to a small extent, Ontario. The country's major natural gas resources are shown in Figure 16. Canada's total proven reserves were an estimated 2.1 trillion cubic metres (m^3) at the end of 1981. Based on 1982 production rates, this amount could last 30 years. As further discoveries are made in conventional and frontier areas, the country's known resources could increase significantly.

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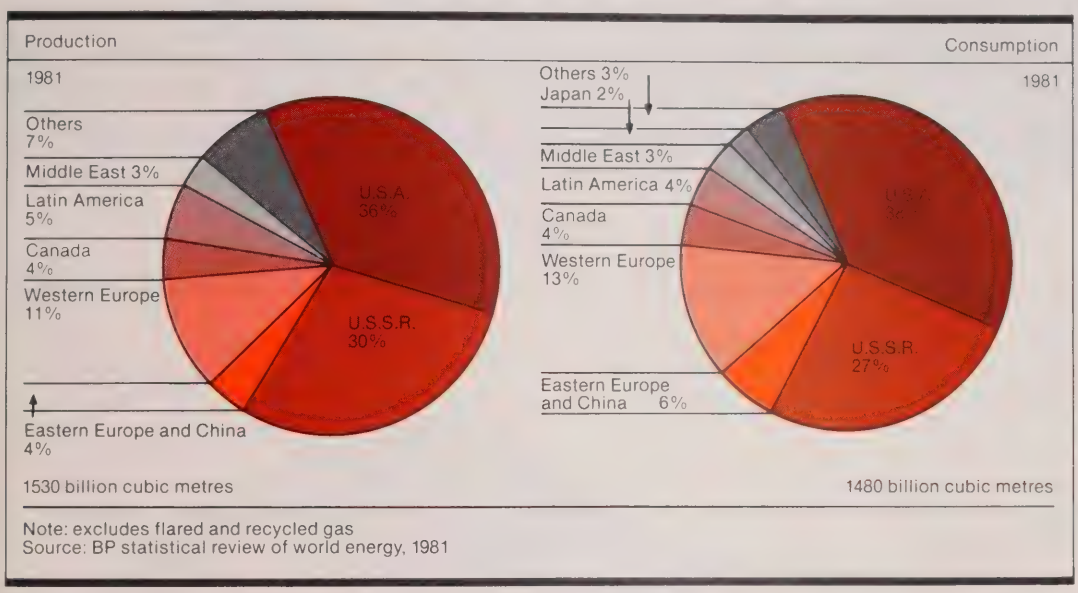

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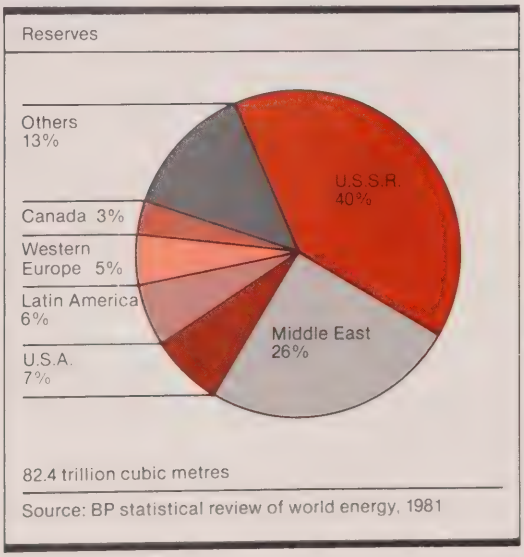

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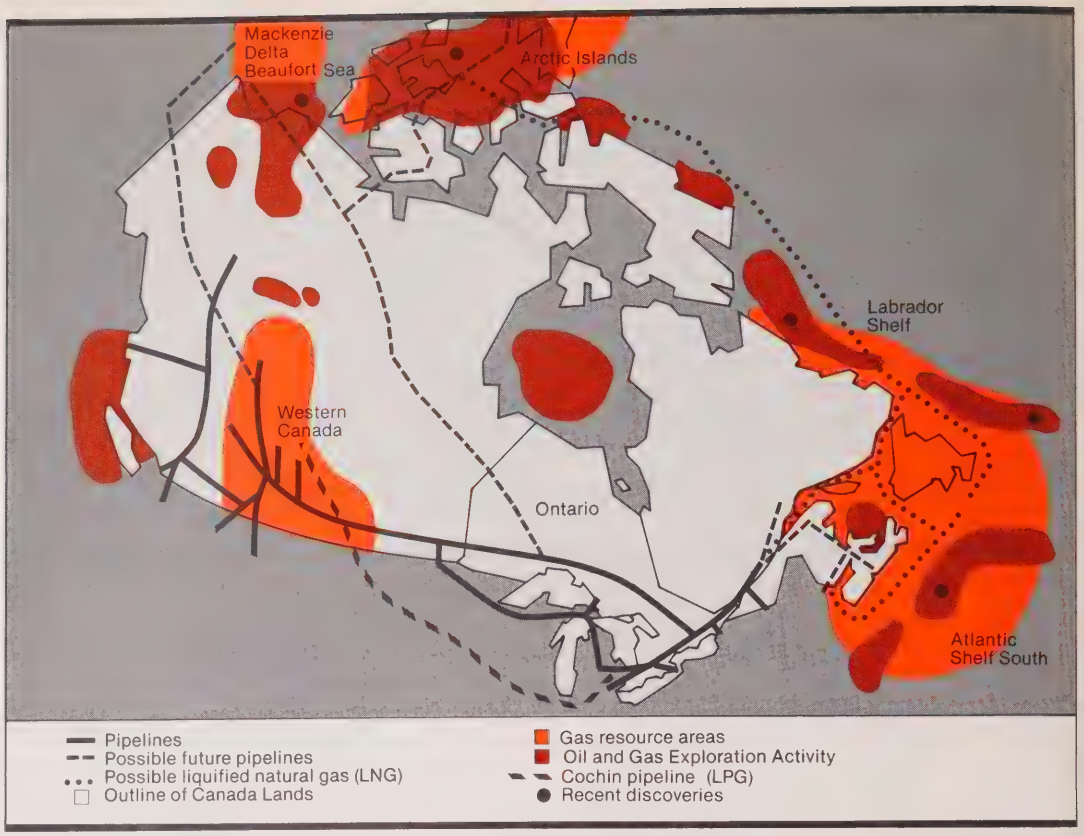

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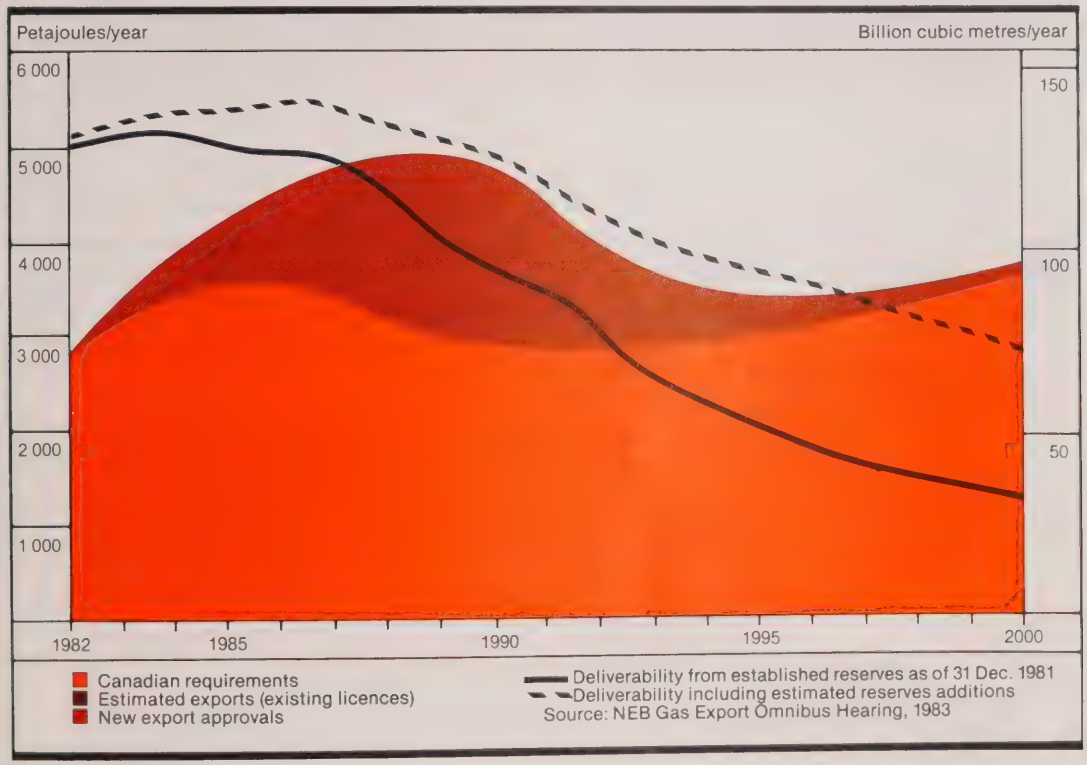

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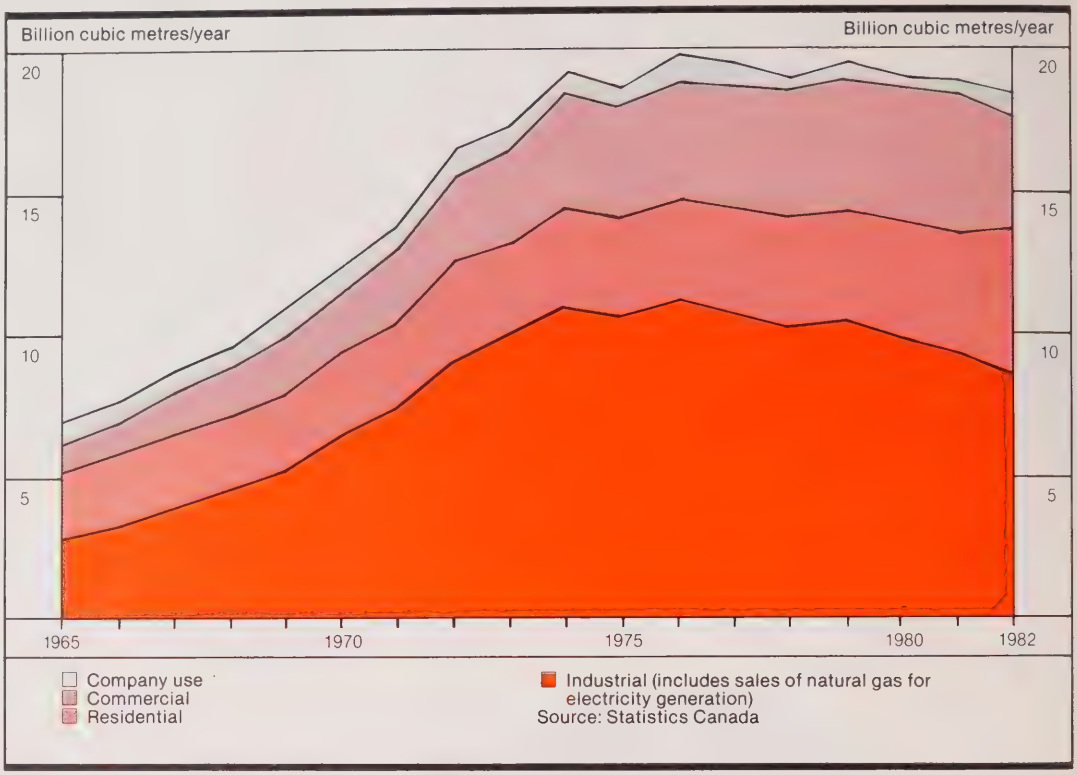

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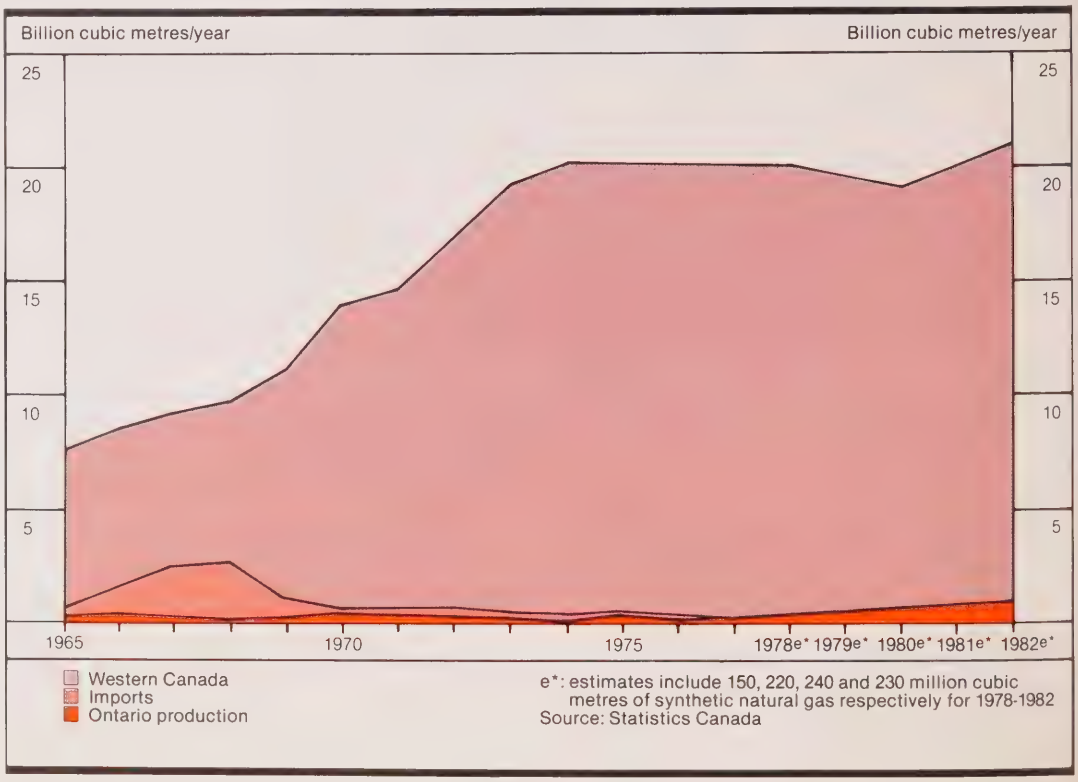
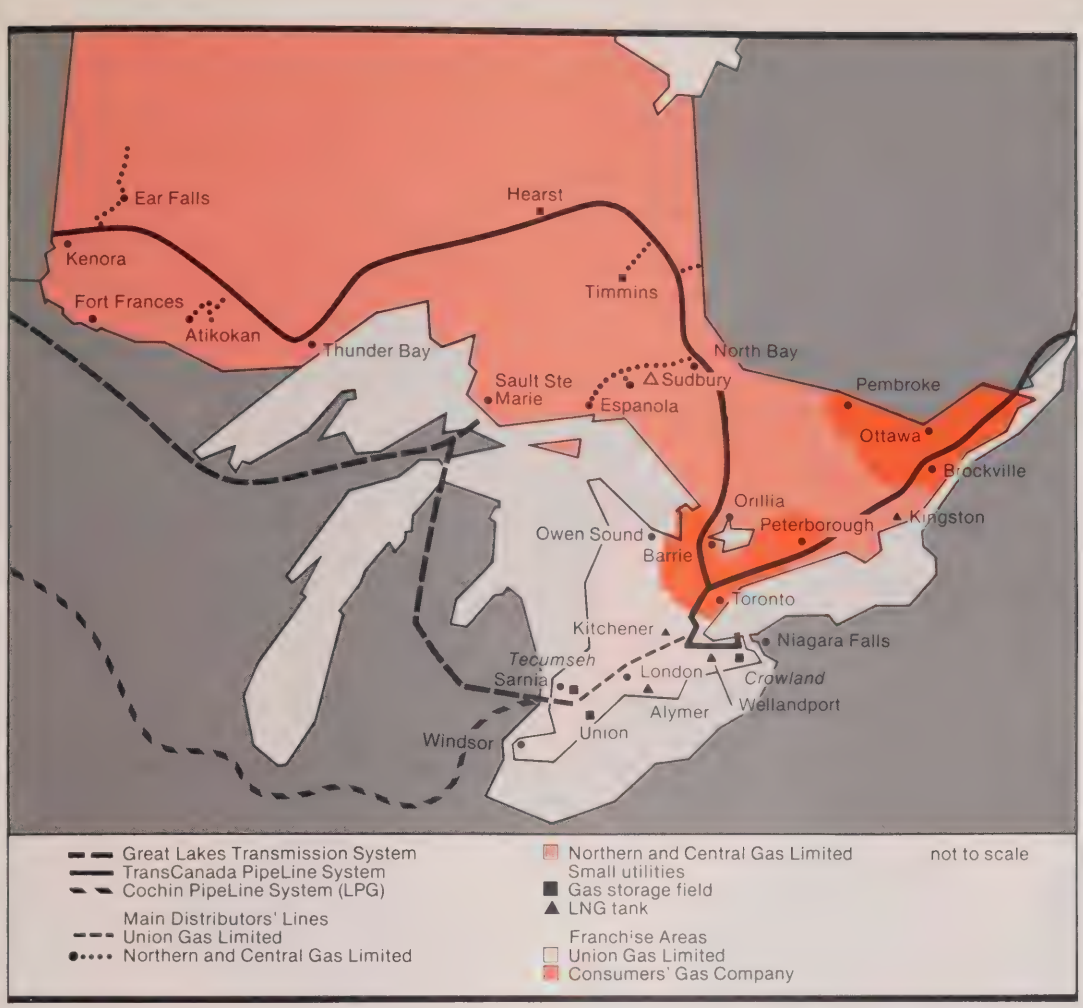
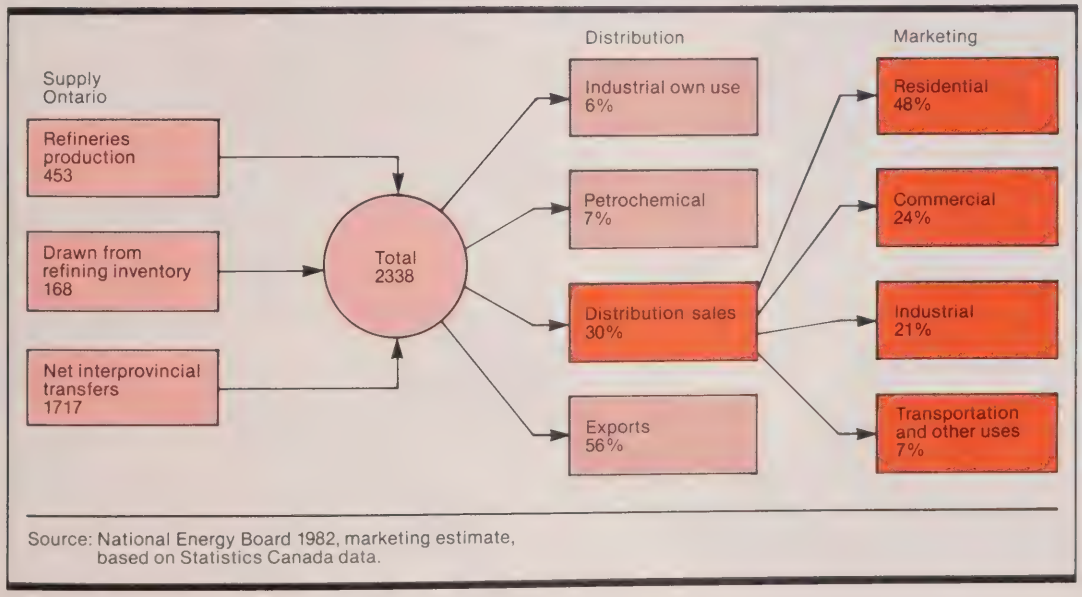
Almost all of the natural gas used in Ontario originates in Alberta. Imports of natural gas from the United States were phased out by 1977.





Natural gas pipelines in Ontario
Figure 20
The TransCanada PipeLine and Great Lakes Transmission systems transport natural gas from Western Canada to Ontario. It is widely distributed within the province.



Source: National Energy Board 1982, marketing estimate, based on Statistics Canada data.

Propane supply and demand in Ontario, 1982 (thousand cubic metres)
Figure 21
Propane is used in Ontario primarily as a petrochemical feedstock, for industrial purposes and for space heating. Its use as a transportation fuel is growing rapidly.

Coal

Canadian coal supply and demand – *Canada has vast reserves of coal, and demand is growing, but slowly.*
Ontario's coal consumption – *Ontario Hydro and Ontario's steel industries together consume about half of the coal needed in Canada each year.*
Peat and lignite – *Ontario has significant peat and lignite deposits.*

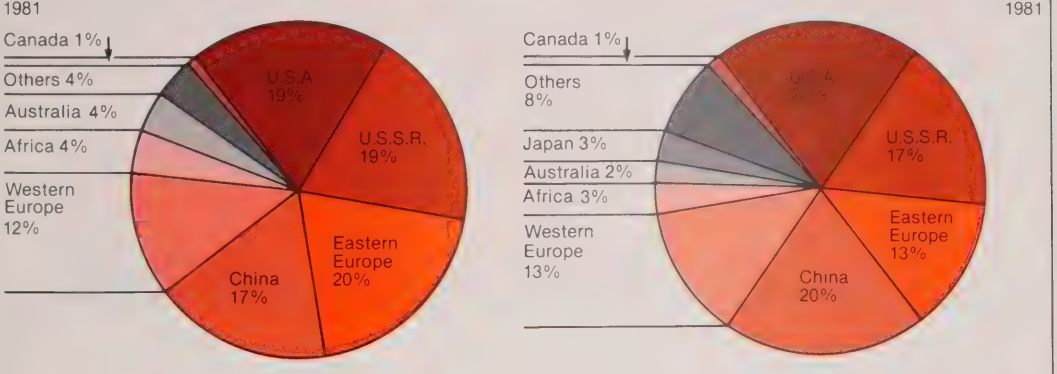
World coal

Coal dominated the world energy scene until the 1950s. In 1950, it supplied 60 per cent of the world's energy needs. Since then, its share has declined steadily to 30 per cent in 1981.

The importance of coal will likely increase in the world energy market. In the past decade, production has risen by about 30 per cent, as a result of sharp price escalation for oil in the 1970s and uncertainties over oil prices and supply. Most of this increased production was used for steel production and electricity generation.

The world's major coal producers are the United States and the Soviet Union, each with production in excess of 700 million tonnes in 1981, and China with approximately 655 million tonnes. Together these three countries accounted for about 55 per cent of both world coal production and consumption (Figure 22).

World coal production should more than double by the year 2000, according to the World Coal Study released in 1981 by the Massachusettes Institute of Technology.



Sources: Production data from Oil and Energy Trends
1982 Statistical Review consumption data from
BP statistical Review of World Energy 1981

World coal production and consumption
Figure 22
The world supply and demand picture for coal is completely different from that of oil – the large coal consuming countries are also the dominant producers.

The world has abundant coal resources. They have been estimated at more than 10 000 billion tonnes. Less than 16 per cent of the currently estimated recoverable reserves of 663 billion tonnes (Figure 23) would be consumed by the year 2000, according to the World Coal Study. This represents only about one per cent of the estimated total resources.

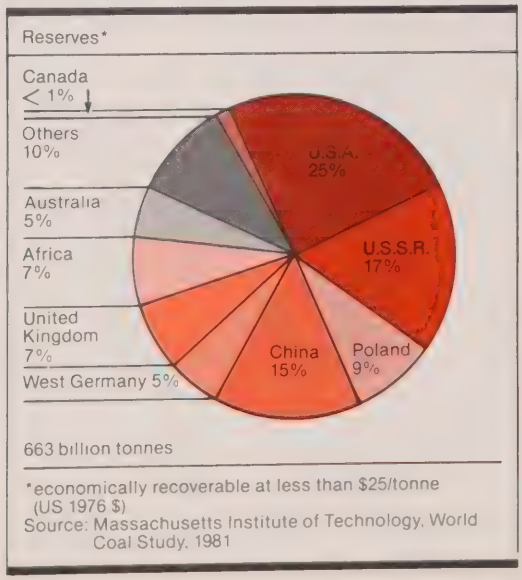
Canada's coal supply and demand

Canada accounts for about one per cent of total world production and consumption of coal. The country has 475 billion tonnes of coal, including lignite. Of this amount, the National Energy Board (NEB) estimated, in 1981, that 5.9 billion tonnes (equivalent to a 147-year supply based on 1981 production rates) can be recovered economically with today's technology. More than 95 per cent of the country's known coal resources are in British Columbia, Alberta and Saskatchewan. The rest is in Eastern Canada, primarily in New Brunswick and Nova Scotia.

Despite Canada's significant coal resources, the country has been a net importer of coal. Transportation costs have a major influence on coal trade. Coal from Western Canada costs up to 50 per cent more in Ontario than coal from the United States.

Canada produced 42.8 million tonnes of coal in 1982, more than double the 1970 figure. During this time, Canada's coal exports quadrupled, due largely to Japanese demand for coal for its steel industry. Other major customers include South Korea, western Europe and Brazil. In 1982, exports reached 15.5 million tonnes. However, imports amounted to 16 million tonnes, making Canada a net importer of only 0.5 million tonnes.

Since 1950, Canada's coal consumption has fallen substantially relative to other fuels. In 1982, coal supplied 10 per cent of the country's energy requirements, down from nearly 50 per cent in the 1950s. Despite this decline, the demand for coal has increased in absolute



*economically recoverable at less than $25/tonne (US 1976 $)
Source: Massachusetts Institute of Technology, World Coal Study, 1981

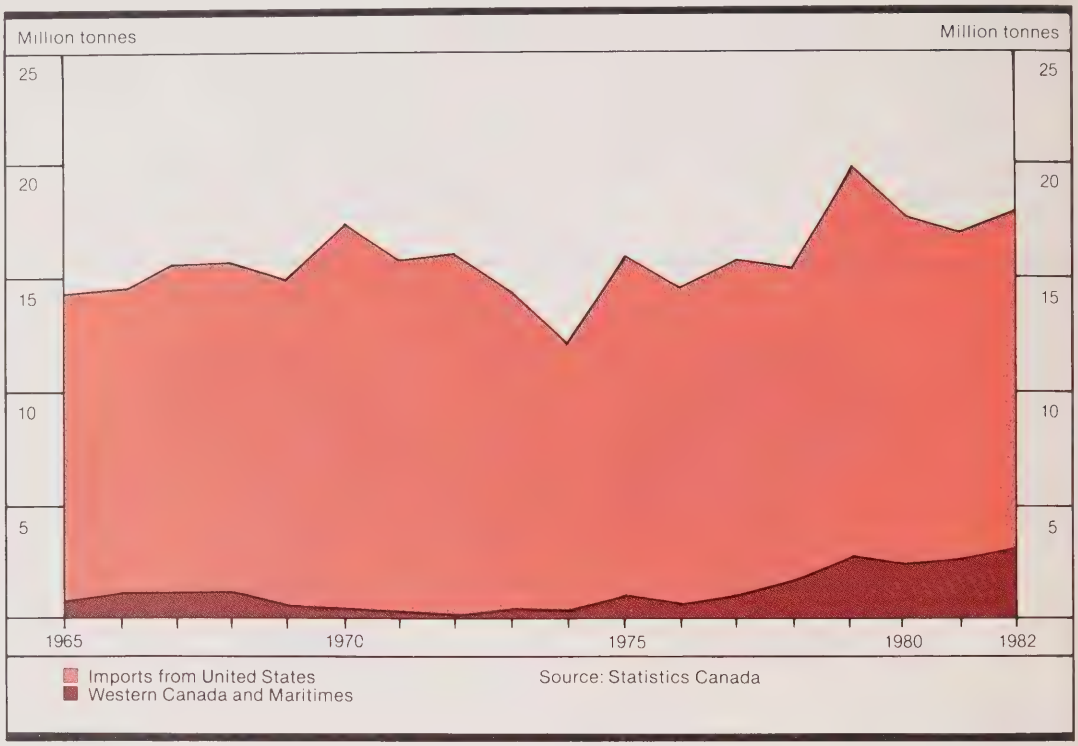
Proven world coal reserves*
Figure 23
The world's coal reserves are widely distributed geographically. Despite Canada's small share of the total, the country has enough to meet its needs for more than a century.

terms, mainly in the last six years. Total consumption in 1982 was 41.2 million tonnes, or 47 per cent above the 1970 level.

About three-quarters of the coal consumed today is used to generate electricity. Coal-fired generation provides about 15 per cent of the electrical power used in Canada. The NEB estimated that the amount of coal needed to generate electricity will more than double by the year 2000, when coal-fired generation is expected to produce about one-quarter of Canada's electricity.

Steel manufacturing accounts for almost one-quarter of Canada's coal consumption. Roughly two per cent is used for space and process heating in other industries.

Coal supply in Ontario
Figure 24
Ontario purchases most of its coal supply from the United States. Increasing amounts are obtained from Western Canada and Maritimes.



Ontario's coal consumption

Ontario is a major coal consumer, accounting for 18 million tonnes annually, or roughly half of Canada's total consumption. In 1982, coal met about 16 per cent of Ontario's primary energy needs, down significantly from 22 per cent in 1965.

The province relies heavily on supplies from the United States and other parts of Canada to meet its needs (Figure 24). In 1982, imports from the United States met over three-quarters of Ontario's coal requirements. The remainder came from Western Canada and the Maritimes. While shipping coal from the Maritimes is less expensive than transporting it by rail from the west, production facilities in the Maritimes are limited. Ontario Hydro has expanded its use of western Canadian coal to diversify its supply sources and to obtain low-sulphur grades that can be blended with higher-sulphur, imported coal.

Virtually all the coal consumed in Ontario is used either to generate electricity (64 per cent) or to make steel (33 per cent). The residential, commercial, industrial (other than steel manufacturing) and transportation sectors accounted for only three per cent of total Ontario coal use in 1982, well below their 39 per cent share in 1965 (Figure 25).

The amount of coal used to generate electricity has tripled since 1965. However, the lower life cycle costs of nuclear-fuelled generating stations has reduced the advantages of coal-fired plants. In 1982, coal accounted for about one-third of total generation. The demand for coal from the steel industry varies with the production of automobiles, appliances and construction equipment. The demand for these products has been weak in recent years.

Peat and lignite

Ontario does not have any high quality (bituminous) coal deposits, but it does have an abundant supply of peat and at least one large deposit of lignite. Both could displace oil and coal in certain applications.

Peat is vegetable matter which has decomposed in water and is partly carbonized. It has a lower heat value and a higher moisture content than coal. In Canada, most of the peat comes from swamps; it is commonly known as the soil conditioner peat moss. The more compressed and decomposed lower layers can be burned directly, converted into fuel pellets, processed into methanol and other fuels, or used as a chemical feedstock.

Ontario has about 26 million hectares of peatland. Almost one-third of this supply is south of the permafrost line. It has an energy equivalent of about 4.2 billion cubic metres (m^3) of oil. This is nearly six times the energy available from Canada's established, conventional oil reserves.

Renewable energy normally includes water-power, direct solar energy, wind energy, biomass energy (from plant materials), tidal and wave energy, and geothermal energy (heat from inside the earth). It often includes recoverable energy or energy from waste, such as garbage, sewage, manure and residues of the forest products industry.

This section focuses on renewable energy, as well as experimental high-technology sources such as hydrogen and fusion systems. It excludes a discussion of water-power since this appears in a previous section (page 28).

International setting

Renewable energy resources are unevenly distributed internationally. Canada and Sweden, for example, have great biomass and hydroelectric potential; Southern Europe, the Pacific region, and the United States are well suited for solar energy development; and geothermal sites are located primarily in New Zealand, Japan, Turkey and the United States.

Over the past two years, the cost effectiveness of investment in renewable energy technologies has come under increased scrutiny because of high interest rates and reduced pressure on conventional energy prices. However, the International Energy Agency (IEA) has recommended that research, development and demonstration of these technologies should be maintained despite weakness in oil markets and budgetary constraints in most jurisdictions.

Cumulative expenditures on renewable energy technology by IEA member countries was $2.5 billion (U.S.) over the 1978-80 period. Recent IEA estimates indicate that renewable energy sources could meet 0.2 per cent of total primary energy demand by 1990 and one per cent by 2000 in the non-Communist industrialized world. These projected levels of use correspond to about 11 million cubic metres of oil equivalent in 1995 and 66 million cubic metres by 2000.

Developments in Canada

Renewable energy in the form of hydroelectric power currently meets approximately 24 per cent of Canada's total primary energy requirements. Other renewables, principally wood waste, contribute approximately three per cent. Renewable energy use is currently concentrated in certain industrial sectors such as the forest products industry.

The federal government has instituted several new renewable energy programs and strengthened existing programs since the introduction of the National Energy Program (NEP) in October, 1980.

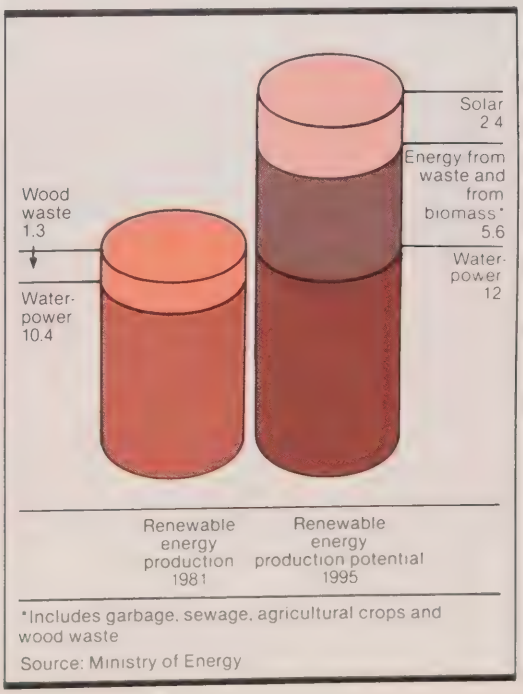
One of these is the Forest Industry Renewable Energy (FIRE) program. It offers grants to assist the forest industry to purchase equipment to use wood and wood residues as fuel. This program has been expanded to include other organic materials, such as agricultural and municipal wastes, and to cover all industrial and commercial establishments. The Program of Assistance to Solar Equipment Manufacturers (PASEM) provides grants to the solar equipment industry for design and development of solar heating equipment. The Energy from the Forest (ENFOR) program finances research and development on biomass energy alternatives. Small hydroelectric demonstration programs are eligible for federal grants as are feasibility studies for small hydroelectric sites and turbine inspections. These and other similar programs were allocated $380 million over the 1979-1985 period.

In addition to direct grants available, various tax measures also encourage the use of renewable energy technology. Sales tax exemptions, equal to nine per cent at the wholesale level, apply to production machinery and equipment used in energy from waste and biomass applications, including wood stoves. Investment tax credits are available for equipment used in the manufacturing and processing of alcohol and refuse-derived fuels. As well, income tax credits apply to corporate profits derived from the sale of alcohol fuels, refuse-derived fuels, steam, and electricity.

The federal government has also shared the cost of a number of renewable energy projects with the provinces and the private sector. Among these are the development of peat as a fuel source for a pulp and paper plant in Newfoundland, a study on the commercial applications of geothermal power in British Columbia, and a hybrid wind-diesel project in Ontario.

Developments in Ontario

In 1981, renewable energy met about 13 per cent of Ontario's primary energy needs (Figure 41). Almost nine tenths of this came from water-power. Wood waste provided most of the balance.



The potential of renewable energy in Ontario by 1995
Figure 41
Renewable energy could contribute the equivalent of 20 million cubic metres of oil by 1995. This is approximately 70 per cent more than its current level.

By 1995 renewable energy could supply the energy equivalent of 20 million cubic metres of oil. Up to two-fifths of this amount could come from sources other than water-power, such as wood waste, biomass and solar energy.

The Ontario government encourages the development of a variety of renewable energy sources. It sponsors demonstrations of energy from waste and biomass, solar energy, wind power and small-scale hydraulic power. It also funds research in high-technology sources, such as hydrogen and fusion systems, which have a long term potential.

Energy from waste and biomass Energy from waste and biomass includes energy from garbage, sewage, wood and wood residues, and agricultural crops and waste. In 1981, wood waste (sawdust, wood chips, bark and other mill residues) alone supplied 1.5 per cent of Ontario's total energy, while the amount of energy from other forms of waste and biomass was insignificant.

The most immediate opportunity to use proven technologies is in municipal solid waste installations. Some additional technological developments are necessary to increase the use of wood and wood residues produced by the forest industry, tree plantations, and agricultural crops and waste for energy purposes. The following sections examine each of these areas.

Municipal solid waste The average Ontario resident produces one to 1.5 kilograms of garbage every day, equivalent to approximately six million tonnes a year in the province. About half of this is paper and much of it is highly combustible.

At present, almost all is buried as landfill or incinerated with no heat recovery, despite the proximity of major energy consumers and problems associated with urban waste disposal.

An average tonne of garbage contains the energy equivalent of about one-sixth of a cubic metre of oil. If all of Ontario's combustible garbage were burned, the energy generated annually would be equivalent to 1.1 million cubic metres of oil, or enough energy to heat about 300 000 homes. Clearly, this represents a significant untapped energy resource for Ontario.

Although garbage-to-energy technology has been proven in European installations and most recently in the United States, Ontario's experience with these systems is limited. Ontario has only one municipal solid waste plant – Tricil/SWARU (Solid Waste Reduction Unit) in Hamilton. The plant currently burns about 110 000 tonnes of garbage a year. The steam and electricity produced is equivalent to almost 19 200 cubic metres of oil a year, or enough energy to heat about 5500 homes. Some of the steam is used interally, but most is used to generate electricity which is sold to Ontario Hydro.

A number of proposals for other municipal solid waste plants in Ontario are under study. However, no new solid waste plants are expected to be in operation before at least 1984, because of the complexity of the development stages involved (Figure 42).

Sewage sludge is another municipal waste with possibilities as an energy source. The Lakeview Water Pollution Control Plant in Peel Region will begin incinerating sludge by the end of 1983. In this project, partially funded by the provincial and federal governments, the steam produced by burning the sludge will supply most of the plant's energy needs.

Methane gas produced from decomposing garbage in landfill sites may prove to be another valuable energy source. Recovering the methane also solves a gas seepage problem that

Some existing and proposed renewable energy projects in Ontario
Figure 42
Municipal solid waste installations offer immediate opportunities to demonstrate the use of renewable energy. A number of installations are currently under consideration.

		Energy Product	
Energy From Waste Projects	Possible use of waste matter (tonnes/year)	Type	Potential oil displacement* (cubic metres/year)
Hamilton – Tricil/SWARU (existing)	110 000	Steam/Electricity	19 200
London – Victoria Hospital	127 000	Steam/Electricity	22 200
Niagara – Ontario Paper	211 000 586 000	Steam/Electricity Steam/Electricity	36 900 102 500
North Bay – Nordfibre	30 000	Steam	5 300
Ottawa-Carleton – District Heating Project	275 000	Steam/Electricity	48 000
Toronto – Commissioners Street Project – the installation of boilers to existing plant District Heating Incinerator	187 000 380 000	Steam Steam	32 700 66 400
Kitchener-Waterloo – Energy From Waste	66 000	Steam	14 200
Other Projects			
Kitchener Landfill Gas Project (existing)	—	Landfill Gas	700
Lakeview Water – Pollution Control Plant Energy Recovery System (under construction)	110 000 litres/day	Steam	24 600

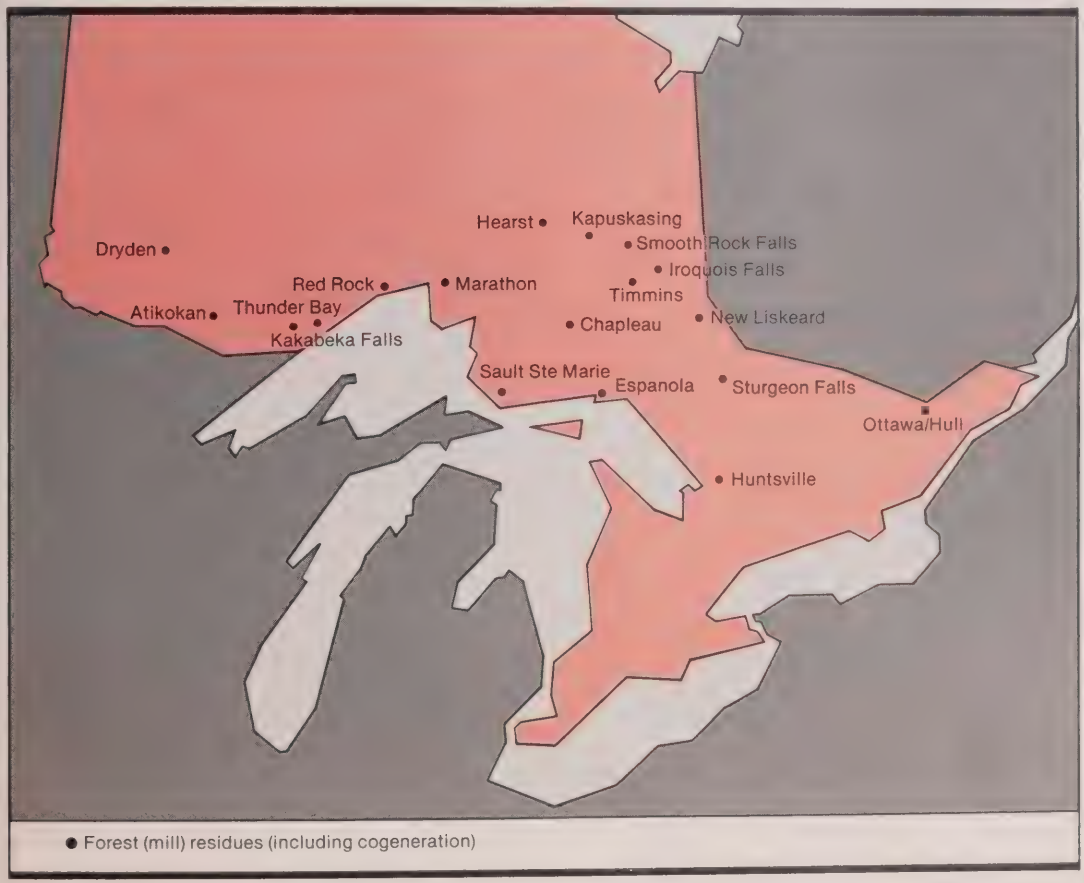
*actual displacement will depend on the number of customers and usage

Note: Unless otherwise indicated, these projects are under evaluation. Not all of them may go ahead since some of them might compete for the same refuse.

can lead to explosions. In a project sponsored by the Ontario government, a landfill site in Kitchener supplies much of the gas needs of a nearby concrete pipe company. Other landfill sites in Ontario are also under consideration for methane gas production.

Wood waste Ontario's forestry industry produces over three million dry tonnes of sawdust, bark, wood chips and other types of mill residues each year. The energy-intensive pulp and paper industry has burned its wood waste to produce steam and electricity for its own use since before the Second World War. As fuel prices have escalated over the last decade, it has become more economical for Ontario's forestry industry to intensify its energy-from-wood waste efforts.

In 1981, wood waste, including bark, chips, sawdust and spent pulping liquor, supplied about 40 per cent of the pulp and paper industry's energy needs. In 1972, when energy prices were considerably lower, wood waste supplied about 32 per cent (Figure 43).



Some mills where wood waste is used as an energy source
Figure 43
The energy-intensive pulp and paper industry has been using wood waste since before the Second World War. Mills throughout Ontario currently meet about 40 per cent of their energy needs through wood waste.

Although wood waste currently supplies much of the forestry industry's energy needs, approximately 0.7 million dry tonnes of mill waste (mainly sawdust, bark and chips from sawmills) continue to be discarded annually. This material could supply energy equivalent to nearly 360 000 cubic metres (m^3) of oil, enough to heat more than 100 000 homes.

Large amounts of wood waste are also left in Ontario's forests after logging operations. Only about half of each tree cut actually goes to a mill; the rest – the stump, tree top and branches – is left on the forest floor. This amounts to six to 10 million dry tonnes of bush residue a year, with energy equivalent to about two to 3.5 million m^3 of oil. Economical gathering and transportation methods must be developed to take advantage of this supply.

Recently, there have been a number of developments in the wood waste field in Ontario. Shell Canada now produces dry, compacted, easy-to-transport wood pellets from sawmill waste that can be used instead of oil, coal or natural gas in modified boilers. The company's plants in Hearst and Iroquois Falls can each produce up to 100 000 tonnes a year of pellets.

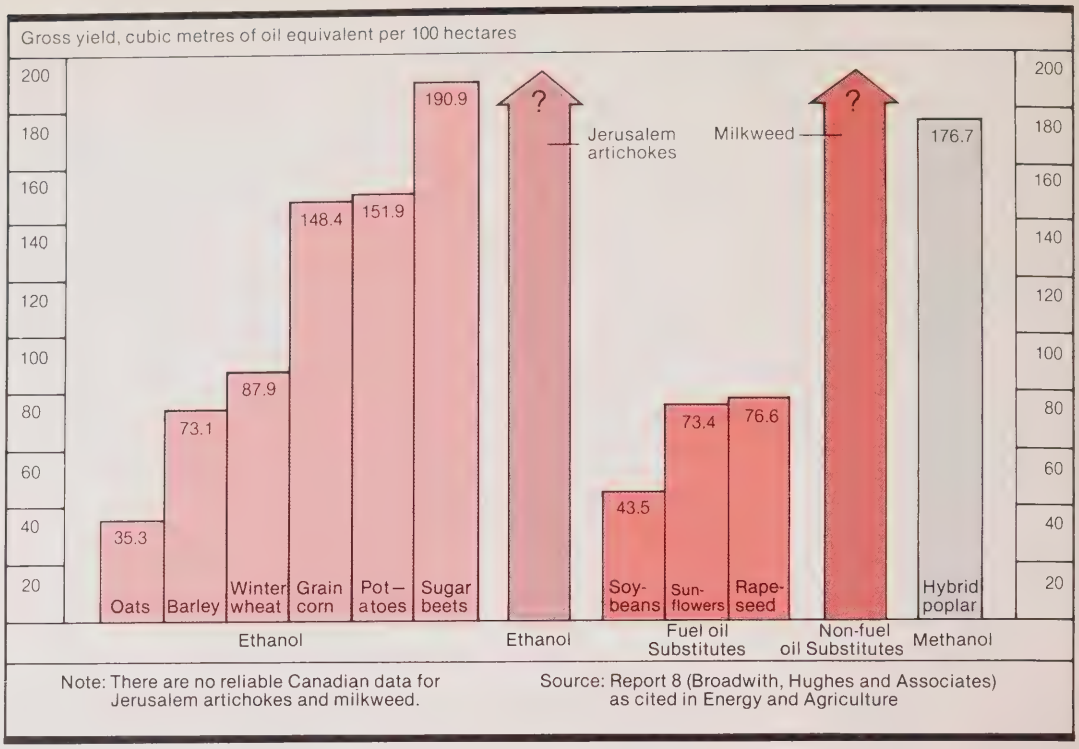
A further development in wood-to-energy technology is the wood gasifier, a system that converts wood to a gas. A plywood mill in Hearst uses a gasifier to convert 27 000 tonnes of wood waste a year into usable energy.

In a project assisted by the provincial and federal governments, a sawmill in Kakabeka Falls uses wood residue instead of propane as the fuel for heating a drying kiln. Also, in a demonstration project sponsored by the Ontario government, Grenville Christian College near Brockville uses a newly-developed automatic system to burn wood residue from nearby mills.

The potential applications of such systems are widespread. Ontario has 1500 secondary, wood-using enterprises that could use wood waste to supply much of their energy needs in the future.

Energy plantations Tree plantations for energy purposes may become common in

How crops compare as fuel sources (gross yield, cubic metres of oil equivalent per 100 hectares)
Figure 44
Agricultural crops are a possible source of fuel. Ethanol production from corn, potatoes and sugar beets, and methanol production from the hybrid poplar offer good potential.



Note: There are no reliable Canadian data for Jerusalem artichokes and milkweed.

Source: Report 8 (Broadwith, Hughes and Associates) as cited in Energy and Agriculture

Ontario. In recent years, rapidly maturing varieties of hybrid poplar trees have been developed. The trees could be grown on a very short rotation cycle (two to 12 years) and would normally not need fertilizer once the root systems become well established. Plantations could be established on farmland that is too wet or stony for conventional agriculture.

Under a current program with Domtar Limited, 2023 hectares of poplar plantations will be established in the Cornwall area by 1985 as a source of wood fibre for its pulp operations. Similar plantations could be developed for energy supply purposes.

In 1981, the Ontario government established the Ontario Tree Improvement and Forest Biomass Institute in Maple, to study the genetics of fast-growing trees, forest production and technology.

Agricultural crops and waste Ontario farmers may eventually be able to produce much of the energy they need from materials available on the farm, such as manure, straw, crops, other plants and wood.

One of the most immediate opportunities for on-farm energy production is recently developed technology that converts manure to methane. Several of these 'biogas' systems are already in commercial operation in the United States, but further development is needed to make farm-scale operations economical in the Canadian climate. The Ontario government sponsors a program at the University of Guelph to develop economical, small-scale methane systems for Ontario farmers.

Conventional crops such as corn, sugar beets and potatoes, and "energy crops" such as Jerusalem artichokes could be grown by Ontario farmers to produce ethanol, which can be used straight or blended with gasoline as a vehicle fuel (Figure 44). The Ontario government has funded two demonstration, farm-scale ethanol stills in the province.

Various vegetable oils, both alone and blended with diesel fuel, run tractors in an experiment at the University of Guelph. Further testing is required, but if the engines operate satisfactorily farmers would simply need a crusher to manufacture their own fuel from such plants as soybean and rapeseed.

Wood waste from nearby wood industries could be another low-cost energy alternative for Ontario farmers. Wood shavings and sawdust from local wood industries currently heat two greenhouses in the Holland Marsh area, in projects sponsored by the provincial and federal governments. Grain residues and straw may also eventually be used to help heat farm buildings.

Other projects demonstrate how the heat generated in a barn can be captured by a heat exchanger and used to heat adjacent buildings, and how a heat exchanger at the end of a corn dryer uses the warm exhaust to heat the incoming air.

Another source of surplus heat – from locations such as power stations, steelworks, pulp and paper mills or refineries where high-energy machinery continually exhausts heat – could provide farmers with another inexpensive energy alternative if food production facilities, ideally greenhouses, can be located nearby. A greenhouse adjacent to the TransCanada PipeLines Limited compressor station in Ramore (in northern Ontario) takes advantage of the low-cost, excess heat available there to grow tree seedlings.

Solar Energy Across Ontario, solar energy supplies some of the hot water and space heating needs of numerous offices, industries, institutions and homes. This is quite a change from the early 1970s, when there were few solar

systems in the province.

Much of this growth is due to the financial and technical support that Ontario's solar industry has received from the provincial and federal governments. Between 1976 and mid-1982, these governments contributed almost $15 million to help finance nearly 400 active and passive solar projects across the province. These projects are designed to find the most economical uses for solar energy in Ontario.

Residential passive solar features, solar-heated swimming pools and industrial process heat systems are the strongest competitors to conventional energy sources. Almost all solar-heated outdoor swimming pools recover their capital costs within five years. Increased production and a rapidly developing technology may enable some commercial and industrial systems soon to achieve a 10-year payback.

fact, the projects selected in the second year of the Comercial/Industrial Solar Demonstration Program were 50 per cent more cost effective than those chosen in the first year.

This kind of progress has helped turn the solar products business in Canada into a multi-million dollar industry. About 75 per cent of Canada's nearly $30 million a year solar industry is based in Ontario. The solar industry provides more than 200 direct and 700 indirect jobs in the province. A range of solar products has been developed from the basic flat-plate collectors to complete, ready-to-install systems and photovoltaic devices. Ontario solar companies currently export about 20 per cent of their production, primarily to the United States, the Middle East and East Africa.

Some recent applications of solar energy use in Ontario are listed in Figure 45. Also, a type of residential solar water installation now

Name	Location	Application
Mohawk Regional Hospital Laundry	Hamilton	Water Heating
Polysar Ltd.	Sarnia	Domestic water
Confederation College	Thunder Bay	Water heating
Saint James Apostle Church	Sharon	Space heating
City of Mississauga	Mississauga	Indoor pool
Talisman Resort	Kimberly	Pool and service water
Ontario Correctional Institute	Brampton	Water heating
Christie Brown and Co.	Toronto	Bakery
Medallion Film Laboratories	Toronto	Film processing
Campbell Soup Co.	Toronto	Boiler preheat
Applewood Public School	St. Catharines	Space heating in conjunction with a heat pump
Dixie Carwash Ltd.	Orangeville	Carwashing
City of Cambridge	Cambridge	Pool heating
Aquafarms Canada	Feversham	Fish farming
Aylmer Senior Citizens Home	Aylmer	Space heating with annual storage for a multiple family home
McDonald's Restaurants (20 locations)	Throughout Ontario	Service water
Ontario Inc.	Drayton	Plaza service water
Maedel's Beverages Ltd.	Essex	Bottle washing
Provincial Park Comfort Stations (20)	Throughout Ontario	Water heating for comfort stations
Passive Solar Houses	Throughout Ont.	Water heating
Ontario Hydro Passive Solar Project	Throughout Ontario	

*Unless otherwise indicated projects are active solar demonstration projects.

Note: These solar energy systems are supplemented by another energy form such as electricity or natural gas.

Some solar demonstration projects in Ontario
Figure 45
About 400 active and passive solar systems are in place in a variety of locations across the province. Some of the more recent applications include process heating and water heating in restaurants, homes, and car washes.

Ontario has the largest number of active solar systems in use in Canada. Solar energy helps heat nearly 600 000 litres of water every day at the Mohawk Regional Hospital Laundry in Hamilton. Four Ontario solar manufacturers supplied 2000 square metres of collectors for the project, which is several times the size of any other existing system in Canada. It is funded by the provincial and federal governments.

Much of the funding for solar energy projects in Ontario comes from the Commercial/Industrial Solar Demonstration Program, begun by the Ministry of Energy in 1981 and co-sponsored by the federal government since 1982. It is the first government attempt in Canada to assist the private sector in finding markets. In the first two years of the program, $4.5-million was awarded for 77 solar systems across Ontario. Twenty per cent of the program's funding is available to municipal and non-profit groups.

Growing expertise in matching the right solar system with the most economical application has produced remarkable improvements in cost/performance ratios. In

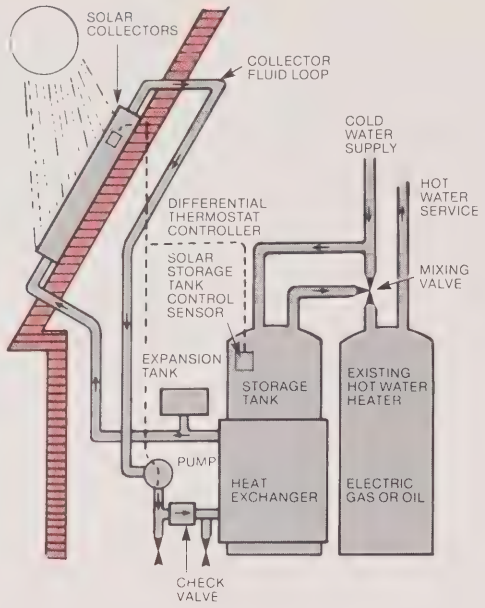
available commercially in Ontario is shown in Figure 46.

Wind energy In northern Ontario, some isolated communities, cottages and telecommunications stations are not connected to an electrical power system. In these locations, diesel-powered generators produce electricity. The increasing cost of diesel fuel, combined with rising transportation costs, particularly for air freight, makes electricity generation extremely expensive in these remote areas.

A number of different energy systems have therefore been examined as alternatives to transmission line extensions or as supplements to diesel installations. These include combined wind-diesel power systems, small-scale water-power units, and gasifiers (systems that convert such materials as wood, peat or lignite to a low grade gas).

Wind energy is a practical supplement to diesel power only where the mean annual wind speed is at least 20 km/h. Such wind conditions occur in coastal areas of the Great Lakes and James Bay. However, over most of Ontario the average winds are light (Figure 47).

Packaged solar hot water heating systems for single-family homes, Toronto
Figure 46
This is an example of a residential solar hot water installation now available commercially in Ontario.



- 2 or 3 collector panels
- net area 4.6 - 5.6 square metres (50 - 60 sq. feet)
- collectors single-glazed with selective surface or flat black paint
- 310 litres (68 gallons) water storage tank
- wrap-around heat exchanger 1.6 square metres (17.5 sq. feet)
- pump, valves, controls, and expansion tank supplied as part of the package to partially heat the hot water

Wind speeds in Ontario
Figure 47
Diesel/wind generation systems are potential energy sources for remote communities. Wind power is a practical supplement where alternative energy sources are expensive and wind speeds are at least 20 km/hr.

Note: Isovents of annual mean wind speed in kilometres per hour at 30 metres altitude

The Ontario government is currently testing an 80-kilowatt wind/diesel system near Sudbury. This sytem mechanically couples a diesel generator with a wind turbine. It is designed to reduce consumption of diesel fuel by 25 per cent. Following successful completion of the testing, a wind-diesel generator will probably be installed in a small community in northern Ontario. Ontario Hydro is currently monitoring the wind characteristics in two candidate communities – Winisk and Fort Severn – along the shore of Hudson Bay.

Hydrogen technology Hydrogen could play a major role in Ontario's energy future. It could be used as a transportation fuel for trains, ships, airplanes, trucks and buses, and ultimately cars, or in fuel cells to generate electricity.

Hydrogen is a secondary energy form, like electricity, which must be manufactured from primary sources. It can be produced from natural gas, coal or from splitting water into hydrogen and oxygen by electrolysis.

Its more widespread use, however, requires further development of technologies for energy conversion (particularly electrolysis), fuel distribution and storage facilities.

The Ontario government and the University of Toronto established the Institute for Hydrogen Systems in January, 1983. The institute is expected to attract experts from Canada and abroad. These experts will work to develop systems that use hydrogen directly as a fuel, or as a feedstock in refinery operations. Hydrogen in methanol and fertilizer production will also be examined. The role of hydrogen in Ontario's energy future is discussed in **Hydrogen – A Challenging Opportunity,** an eight volume report of the Ontario Hydrogen Energy Task Force, published in 1981.

Fusion The harnessing of fusion, the energy source of the sun, is being extensively pursued world-wide (United States, Soviet Union, European Economic Community, Japan). This task is an enormous technical challenge. However, if it is accomplished, the potential benefits are also enormous since the resource base for fusion fuels is essentially inexhaustible.

Fission reactors are the basis of current nuclear power programs. They harness the energy released in the fissioning or splitting of nuclei of heavy elements such as uranium and plutonium. On the other hand, fusion reactors will depend upon the energy released in the fusion process. Fusion is the combining of the nuclei of light elements, in particular, hydrogen. The extensive research and development activities now taking place on fusion are concerned with two isotopes of hydrogen, namely, deuterium and tritium. Fusing a deuterium and tritium nucleus is considered to be the most promising form of fusion reaction.

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This project will have high technology benefits for Ontario industry. With deuterium available from its heavy water production and with its CANDU reactors as a source of tritium, Ontario will be in an excellent position during the next 20 years to supply these basic fuels to the world's fusion reactor development program.

Conservation and Substitution

World setting *– Nations around the world are becoming more efficient in the use of energy.*
Ontario *– Ontario has set oil substitution and conservation targets in the transportation, industrial, residential and commercial sectors.*
Residential sector *– More than 159 000 Ontario homeowners have converted their heating systems from oil to other fuels since October, 1980.*

Renewable energy normally includes water-power, direct solar energy, wind energy, biomass energy (from plant materials), tidal and wave energy, and geothermal energy (heat from inside the earth). It often includes recoverable energy or energy from waste, such as garbage, sewage, manure and residues of the forest products industry.

This section focuses on renewable energy, as well as experimental high-technology sources such as hydrogen and fusion systems. It excludes a discussion of water-power since this appears in a previous section (page 28).

International setting

Renewable energy resources are unevenly distributed internationally. Canada and Sweden, for example, have great biomass and hydroelectric potential; Southern Europe, the Pacific region, and the United States are well suited for solar energy development; and geothermal sites are located primarily in New Zealand, Japan, Turkey and the United States.

Over the past two years, the cost effectiveness of investment in renewable energy technologies has come under increased scrutiny because of high interest rates and reduced pressure on conventional energy prices. However, the International Energy Agency (IEA) has recommended that research, development and demonstration of these technologies should be maintained despite weakness in oil markets and budgetary constraints in most jurisdictions.

Cumulative expenditures on renewable energy technology by IEA member countries was $2.5 billion (U.S.) over the 1978-80 period. Recent IEA estimates indicate that renewable energy sources could meet 0.2 per cent of total primary energy demand by 1990 and one per cent by 2000 in the non-Communist industrialized world. These projected levels of use correspond to about 11 million cubic metres of oil equivalent in 1995 and 66 million cubic metres by 2000.

Developments in Canada

Renewable energy in the form of hydroelectric power currently meets approximately 24 per cent of Canada's total primary energy requirements. Other renewables, principally wood waste, contribute approximately three per cent. Renewable energy use is currently concentrated in certain industrial sectors such as the forest products industry.

The federal government has instituted several new renewable energy programs and strengthened existing programs since the introduction of the National Energy Program (NEP) in October, 1980.

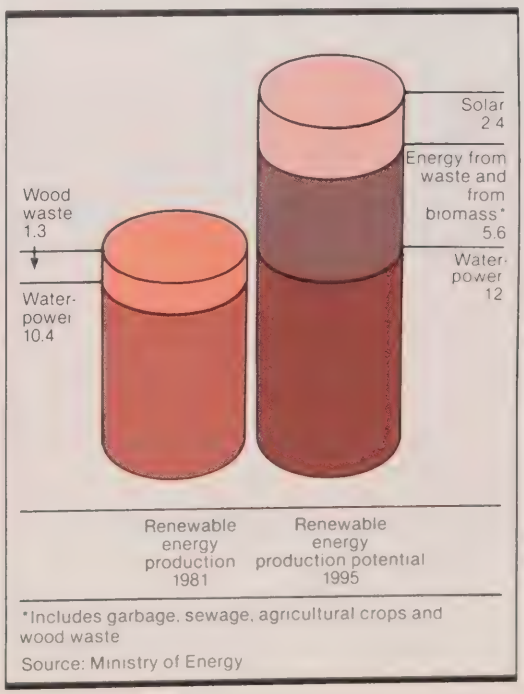
One of these is the Forest Industry Renewable Energy (FIRE) program. It offers grants to assist the forest industry to purchase equipment to use wood and wood residues as fuel. This program has been expanded to include other organic materials, such as agricultural and municipal wastes, and to cover all industrial and commercial establishments. The Program of Assistance to Solar Equipment Manufacturers (PASEM) provides grants to the solar equipment industry for design and development of solar heating equipment. The Energy from the Forest (ENFOR) program finances research and development on biomass energy alternatives. Small hydroelectric demonstration programs are eligible for federal grants as are feasibility studies for small hydroelectric sites and turbine inspections. These and other similar programs were allocated $380 million over the 1979-1985 period.

In addition to direct grants available, various tax measures also encourage the use of renewable energy technology. Sales tax exemptions, equal to nine per cent at the wholesale level, apply to production machinery and equipment used in energy from waste and biomass applications, including wood stoves. Investment tax credits are available for equipment used in the manufacturing and processing of alcohol and refuse-derived fuels. As well, income tax credits apply to corporate profits derived from the sale of alcohol fuels, refuse-derived fuels, steam, and electricity.

The federal government has also shared the cost of a number of renewable energy projects with the provinces and the private sector. Among these are the development of peat as a fuel source for a pulp and paper plant in Newfoundland, a study on the commercial applications of geothermal power in British Columbia, and a hybrid wind-diesel project in Ontario.

Developments in Ontario

In 1981, renewable energy met about 13 per cent of Ontario's primary energy needs (Figure 41). Almost nine tenths of this came from water-power. Wood waste provided most of the balance.



The potential of renewable energy in Ontario by 1995
Figure 41
Renewable energy could contribute the equivalent of 20 million cubic metres of oil by 1995. This is approximately 70 per cent more than its current level.

By 1995 renewable energy could supply the energy equivalent of 20 million cubic metres of oil. Up to two-fifths of this amount could come from sources other than water-power, such as wood waste, biomass and solar energy.

The Ontario government encourages the development of a variety of renewable energy sources. It sponsors demonstrations of energy from waste and biomass, solar energy, wind power and small-scale hydraulic power. It also funds research in high-technology sources, such as hydrogen and fusion systems, which have a long term potential.

Energy from waste and biomass Energy from waste and biomass includes energy from garbage, sewage, wood and wood residues, and agricultural crops and waste. In 1981, wood waste (sawdust, wood chips, bark and other mill residues) alone supplied 1.5 per cent of Ontario's total energy, while the amount of energy from other forms of waste and biomass was insignificant.

The most immediate opportunity to use proven technologies is in municipal solid waste installations. Some additional technological developments are necessary to increase the use of wood and wood residues produced by the forest industry, tree plantations, and agricultural crops and waste for energy purposes. The following sections examine each of these areas.

Municipal solid waste The average Ontario resident produces one to 1.5 kilograms of garbage every day, equivalent to approximately six million tonnes a year in the province. About half of this is paper and much of it is highly combustible.

At present, almost all is buried as landfill or incinerated with no heat recovery, despite the proximity of major energy consumers and problems associated with urban waste disposal.

An average tonne of garbage contains the energy equivalent of about one-sixth of a cubic metre of oil. If all of Ontario's combustible garbage were burned, the energy generated annually would be equivalent to 1.1 million cubic metres of oil, or enough energy to heat about 300 000 homes. Clearly, this represents a significant untapped energy resource for Ontario.

Although garbage-to-energy technology has been proven in European installations and most recently in the United States, Ontario's experience with these systems is limited. Ontario has only one municipal solid waste plant – Tricil/SWARU (Solid Waste Reduction Unit) in Hamilton. The plant currently burns about 110 000 tonnes of garbage a year. The steam and electricity produced is equivalent to almost 19 200 cubic metres of oil a year, or enough energy to heat about 5500 homes. Some of the steam is used interally, but most is used to generate electricity which is sold to Ontario Hydro.

A number of proposals for other municipal solid waste plants in Ontario are under study. However, no new solid waste plants are expected to be in operation before at least 1984, because of the complexity of the development stages involved (Figure 42).

Sewage sludge is another municipal waste with possibilities as an energy source. The Lakeview Water Pollution Control Plant in Peel Region will begin incinerating sludge by the end of 1983. In this project, partially funded by the provincial and federal governments, the steam produced by burning the sludge will supply most of the plant's energy needs.

Methane gas produced from decomposing garbage in landfill sites may prove to be another valuable energy source. Recovering the methane also solves a gas seepage problem that

Some existing and proposed renewable energy projects in Ontario
Figure 42
Municipal solid waste installations offer immediate opportunities to demonstrate the use of renewable energy. A number of installations are currently under consideration.

		Energy Product	
Energy From Waste Projects	Possible use of waste matter (tonnes/year)	Type	Potential oil displacement* (cubic metres/year)
Hamilton – Tricil/SWARU (existing)	110 000	Steam/Electricity	19 200
London – Victoria Hospital	127 000	Steam/Electricity	22 200
Niagara – Ontario Paper	211 000 586 000	Steam/Electricity Steam/Electricity	36 900 102 500
North Bay – Nordfibre	30 000	Steam	5 300
Ottawa-Carleton – District Heating Project	275 000	Steam/Electricity	48 000
Toronto – Commissioners Street Project – the installation of boilers to existing plant District Heating Incinerator	187 000 380 000	Steam Steam	32 700 66 400
Kitchener-Waterloo – Energy From Waste	66 000	Steam	14 200
Other Projects			
Kitchener Landfill Gas Project (existing)	—	Landfill Gas	700
Lakeview Water – Pollution Control Plant Energy Recovery System (under construction)	110 000 litres/day	Steam	24 600

*actual displacement will depend on the number of customers and usage

Note: Unless otherwise indicated, these projects are under evaluation. Not all of them may go ahead since some of them might compete for the same refuse.

can lead to explosions. In a project sponsored by the Ontario government, a landfill site in Kitchener supplies much of the gas needs of a nearby concrete pipe company. Other landfill sites in Ontario are also under consideration for methane gas production.

Wood waste Ontario's forestry industry produces over three million dry tonnes of sawdust, bark, wood chips and other types of mill residues each year. The energy-intensive pulp and paper industry has burned its wood waste to produce steam and electricity for its own use since before the Second World War. As fuel prices have escalated over the last decade, it has become more economical for Ontario's forestry industry to intensify its energy-from-wood waste efforts.

In 1981, wood waste, including bark, chips, sawdust and spent pulping liquor, supplied about 40 per cent of the pulp and paper industry's energy needs. In 1972, when energy prices were considerably lower, wood waste supplied about 32 per cent (Figure 43).

Some mills where wood waste is used as an energy source
Figure 43
The energy-intensive pulp and paper industry has been using wood waste since before the Second World War. Mills throughout Ontario currently meet about 40 per cent of their energy needs through wood waste.

Although wood waste currently supplies much of the forestry industry's energy needs, approximately 0.7 million dry tonnes of mill waste (mainly sawdust, bark and chips from sawmills) continue to be discarded annually. This material could supply energy equivalent to nearly 360 000 cubic metres (m^3) of oil, enough to heat more than 100 000 homes.

Large amounts of wood waste are also left in Ontario's forests after logging operations. Only about half of each tree cut actually goes to a mill; the rest – the stump, tree top and branches – is left on the forest floor. This amounts to six to 10 million dry tonnes of bush residue a year, with energy equivalent to about two to 3.5 million m^3 of oil. Economical gathering and transportation methods must be developed to take advantage of this supply.

Recently, there have been a number of developments in the wood waste field in Ontario. Shell Canada now produces dry, compacted, easy-to-transport wood pellets from sawmill waste that can be used instead of oil, coal or natural gas in modified boilers. The company's plants in Hearst and Iroquois Falls can each produce up to 100 000 tonnes a year of pellets.

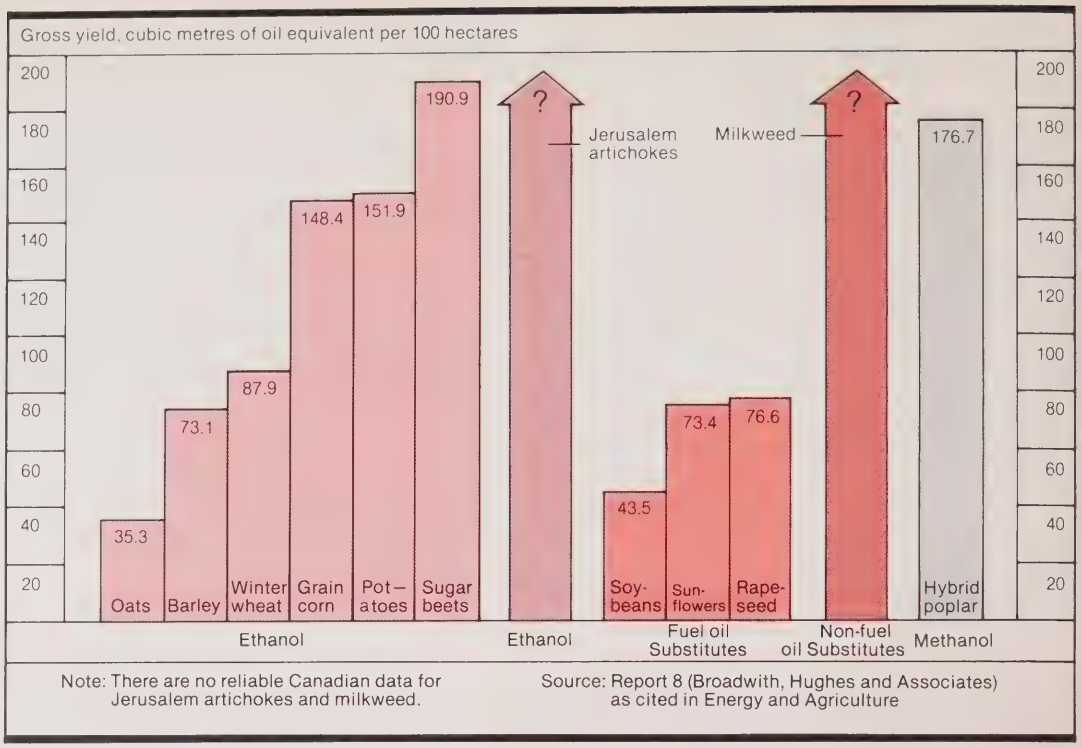
A further development in wood-to-energy technology is the wood gasifier, a system that converts wood to a gas. A plywood mill in Hearst uses a gasifier to convert 27 000 tonnes of wood waste a year into usable energy.

In a project assisted by the provincial and federal governments, a sawmill in Kakabeka Falls uses wood residue instead of propane as the fuel for heating a drying kiln. Also, in a demonstration project sponsored by the Ontario government, Grenville Christian College near Brockville uses a newly-developed automatic system to burn wood residue from nearby mills.

The potential applications of such systems are widespread. Ontario has 1500 secondary, wood-using enterprises that could use wood waste to supply much of their energy needs in the future.

Energy plantations Tree plantations for energy purposes may become common in

How crops compare as fuel sources (gross yield, cubic metres of oil equivalent per 100 hectares)
Figure 44
Agricultural crops are a possible source of fuel. Ethanol production from corn, potatoes and sugar beets, and methanol production from the hybrid poplar offer good potential.



Ontario. In recent years, rapidly maturing varieties of hybrid poplar trees have been developed. The trees could be grown on a very short rotation cycle (two to 12 years) and would normally not need fertilizer once the root systems become well established. Plantations could be established on farmland that is too wet or stony for conventional agriculture.

Under a current program with Domtar Limited, 2023 hectares of poplar plantations will be established in the Cornwall area by 1985 as a source of wood fibre for its pulp operations. Similar plantations could be developed for energy supply purposes.

In 1981, the Ontario government established the Ontario Tree Improvement and Forest Biomass Institute in Maple, to study the genetics of fast-growing trees, forest production and technology.

Agricultural crops and waste Ontario farmers may eventually be able to produce much of the energy they need from materials available on the farm, such as manure, straw, crops, other plants and wood.

One of the most immediate opportunities for on-farm energy production is recently developed technology that converts manure to methane. Several of these 'biogas' systems are already in commercial operation in the United States, but further development is needed to make farm-scale operations economical in the Canadian climate. The Ontario government sponsors a program at the University of Guelph to develop economical, small-scale methane systems for Ontario farmers.

Conventional crops such as corn, sugar beets and potatoes, and "energy crops" such as Jerusalem artichokes could be grown by Ontario farmers to produce ethanol, which can be used straight or blended with gasoline as a vehicle fuel (Figure 44). The Ontario government has funded two demonstration, farm-scale ethanol stills in the province.

Various vegetable oils, both alone and blended with diesel fuel, run tractors in an experiment at the University of Guelph. Further testing is required, but if the engines operate satisfactorily farmers would simply need a crusher to manufacture their own fuel from such plants as soybean and rapeseed.

Wood waste from nearby wood industries could be another low-cost energy alternative for Ontario farmers. Wood shavings and sawdust from local wood industries currently heat two greenhouses in the Holland Marsh area, in projects sponsored by the provincial and federal governments. Grain residues and straw may also eventually be used to help heat farm buildings.

Other projects demonstrate how the heat generated in a barn can be captured by a heat exchanger and used to heat adjacent buildings, and how a heat exchanger at the end of a corn dryer uses the warm exhaust to heat the incoming air.

Another source of surplus heat – from locations such as power stations, steelworks, pulp and paper mills or refineries where high-energy machinery continually exhausts heat – could provide farmers with another inexpensive energy alternative if food production facilities, ideally greenhouses, can be located nearby. A greenhouse adjacent to the TransCanada PipeLines Limited compressor station in Ramore (in northern Ontario) takes advantage of the low-cost, excess heat available there to grow tree seedlings.

Solar Energy Across Ontario, solar energy supplies some of the hot water and space heating needs of numerous offices, industries, institutions and homes. This is quite a change from the early 1970s, when there were few solar

systems in the province.

Much of this growth is due to the financial and technical support that Ontario's solar industry has received from the provincial and federal governments. Between 1976 and mid-1982, these governments contributed almost $15 million to help finance nearly 400 active and passive solar projects across the province. These projects are designed to find the most economical uses for solar energy in Ontario.

Residential passive solar features, solar-heated swimming pools and industrial process heat systems are the strongest competitors to conventional energy sources. Almost all solar-heated outdoor swimming pools recover their capital costs within five years. Increased production and a rapidly developing technology may enable some commercial and industrial systems soon to achieve a 10-year payback.

fact, the projects selected in the second year of the Comercial/Industrial Solar Demonstration Program were 50 per cent more cost effective than those chosen in the first year.

This kind of progress has helped turn the solar products business in Canada into a multi-million dollar industry. About 75 per cent of Canada's nearly $30 million a year solar industry is based in Ontario. The solar industry provides more than 200 direct and 700 indirect jobs in the province. A range of solar products has been developed from the basic flat-plate collectors to complete, ready-to-install systems and photovoltaic devices. Ontario solar companies currently export about 20 per cent of their production, primarily to the United States, the Middle East and East Africa.

Some recent applications of solar energy use in Ontario are listed in Figure 45. Also, a type of residential solar water installation now available commercially in Ontario is shown in Figure 46.

Name	Location	Application
Mohawk Regional Hospital Laundry	Hamilton	Water Heating
Polysar Ltd.	Sarnia	Domestic water
Confederation College	Thunder Bay	Water heating
Saint James Apostle Church	Sharon	Space heating
City of Mississauga	Mississauga	Indoor pool
Talisman Resort	Kimberly	Pool and service water
Ontario Correctional Institute	Brampton	Water heating
Christie Brown and Co.	Toronto	Bakery
Medallion Film Laboratories	Toronto	Film processing
Campbell Soup Co.	Toronto	Boiler preheat
Applewood Public School	St. Catharines	Space heating in conjunction with a heat pump
Dixie Carwash Ltd.	Orangeville	Carwashing
City of Cambridge	Cambridge	Pool heating
Aquafarms Canada	Feversham	Fish farming
Aylmer Senior Citizens Home	Aylmer	Space heating with annual storage for a multiple family home
McDonald's Restaurants (20 locations)	Throughout Ontario	Service water
Ontario Inc.	Drayton	Plaza service water
Maedel's Beverages Ltd.	Essex	Bottle washing
Provincial Park Comfort Stations (20)	Throughout Ontario	Water heating for comfort stations
Passive Solar Houses	Throughout Ont.	Water heating
Ontario Hydro Passive Solar Project	Throughout Ontario	

*Unless otherwise indicated projects are active solar demonstration projects.

Note: These solar energy systems are supplemented by another energy form such as electricity or natural gas.

Some solar demonstration projects in Ontario
Figure 45
About 400 active and passive solar systems are in place in a variety of locations across the province. Some of the more recent applications include process heating and water heating in restaurants, homes, and car washes.

Ontario has the largest number of active solar systems in use in Canada. Solar energy helps heat nearly 600 000 litres of water every day at the Mohawk Regional Hospital Laundry in Hamilton. Four Ontario solar manufacturers supplied 2000 square metres of collectors for the project, which is several times the size of any other existing system in Canada. It is funded by the provincial and federal governments.

Much of the funding for solar energy projects in Ontario comes from the Commercial/Industrial Solar Demonstration Program, begun by the Ministry of Energy in 1981 and co-sponsored by the federal government since 1982. It is the first government attempt in Canada to assist the private sector in finding markets. In the first two years of the program, $4.5-million was awarded for 77 solar systems across Ontario. Twenty per cent of the program's funding is available to municipal and non-profit groups.

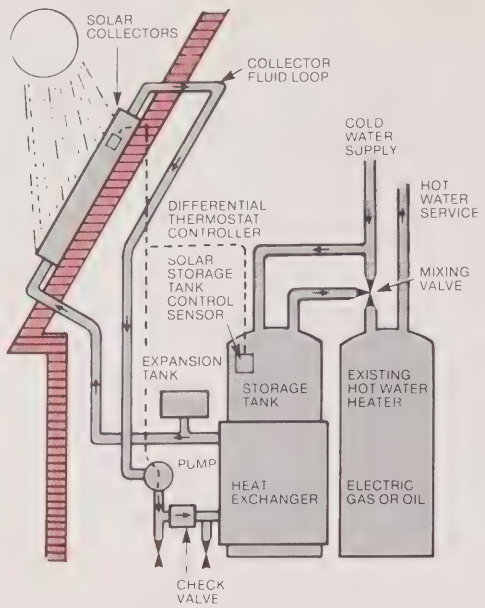
Growing expertise in matching the right solar system with the most economical application has produced remarkable improvements in cost/performance ratios. In

Wind energy In northern Ontario, some isolated communities, cottages and telecommunications stations are not connected to an electrical power system. In these locations, diesel-powered generators produce electricity. The increasing cost of diesel fuel, combined with rising transportation costs, particularly for air freight, makes electricity generation extremely expensive in these remote areas.

A number of different energy systems have therefore been examined as alternatives to transmission line extensions or as supplements to diesel installations. These include combined wind-diesel power systems, small-scale water-power units, and gasifiers (systems that convert such materials as wood, peat or lignite to a low grade gas).

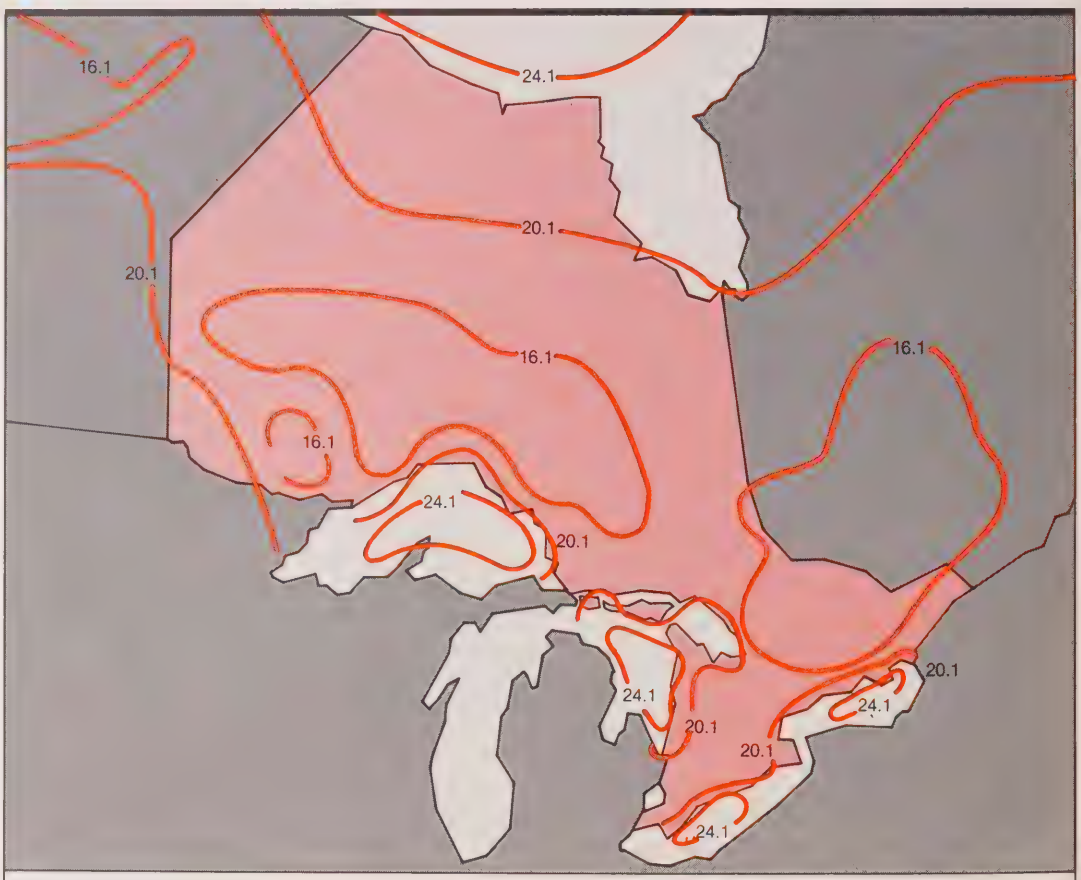
Wind energy is a practical supplement to diesel power only where the mean annual wind speed is at least 20 km/h. Such wind conditions occur in coastal areas of the Great Lakes and James Bay. However, over most of Ontario the average winds are light (Figure 47).

Packaged solar hot water heating systems for single-family homes, Toronto
Figure 46
This is an example of a residential solar hot water installation now available commercially in Ontario.



- 2 or 3 collector panels
- net area 4.6 - 5.6 square metres (50 - 60 sq. feet)
- collectors single-glazed with selective surface or flat black paint
- 310 litres (68 gallons) water storage tank
- wrap-around heat exchanger 1.6 square metres (17.5 sq. feet)
- pump, valves, controls, and expansion tank supplied as part of the package to partially heat the hot water

Wind speeds in Ontario
Figure 47
Diesel/wind generation systems are potential energy sources for remote communities. Wind power is a practical supplement where alternative energy sources are expensive and wind speeds are at least 20 km/hr.



Note: Isovents of annual mean wind speed in kilometres per hour at 30 metres altitude

The Ontario government is currently testing an 80-kilowatt wind/diesel system near Sudbury. This sytem mechanically couples a diesel generator with a wind turbine. It is designed to reduce consumption of diesel fuel by 25 per cent. Following successful completion of the testing, a wind-diesel generator will probably be installed in a small community in northern Ontario. Ontario Hydro is currently monitoring the wind characteristics in two candidate communities – Winisk and Fort Severn – along the shore of Hudson Bay.

Hydrogen technology Hydrogen could play a major role in Ontario's energy future. It could be used as a transportation fuel for trains, ships, airplanes, trucks and buses, and ultimately cars, or in fuel cells to generate electricity.

Hydrogen is a secondary energy form, like electricity, which must be manufactured from primary sources. It can be produced from natural gas, coal or from splitting water into hydrogen and oxygen by electrolysis.

Its more widespread use, however, requires further development of technologies for energy conversion (particularly electrolysis), fuel distribution and storage facilities.

The Ontario government and the University of Toronto established the Institute for Hydrogen Systems in January, 1983. The institute is expected to attract experts from Canada and abroad. These experts will work to develop systems that use hydrogen directly as a fuel, or as a feedstock in refinery operations. Hydrogen in methanol and fertilizer production will also be examined. The role of hydrogen in Ontario's energy future is discussed in **Hydrogen – A Challenging Opportunity,** an eight volume report of the Ontario Hydrogen Energy Task Force, published in 1981.

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Conservation and Substitution

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Ontario *– Ontario has set oil substitution and conservation targets in the transportation, industrial, residential and commercial sectors.*
Residential sector *– More than 159 000 Ontario homeowners have converted their heating systems from oil to other fuels since October, 1980.*

World setting

Conserving energy means achieving some desired effect, such as transportation, home heating or production of goods and services using less energy than formerly.

One of the most widely used measures of a nation's energy efficiency is the ratio of total energy use to total economic output. A decline in this ratio signals an improvement in over-all energy efficiency. During the 1973-80 period, the Organization for Economic Co-operation and Development (OECD) member countries, primarily the industrialized economies of North America, Europe, and Japan, recorded a 12 per cent improvement in this ratio. Furthermore, oil's share of total OECD energy requirements decreased from 54 per cent to 49 per cent over the same period.

To maintain momentum in energy conservation and substitution, the International Energy Agency (IEA) encourages industrialized countries to adopt non-pricing policies, such as the removal of legislative and administrative barriers to energy efficiency, the adoption of financial and tax incentives, the provision of information, education and advice to energy users, and the adoption of minimum efficiency standards.

Policies for improving energy efficiency and reducing dependence on oil vary from country to country. The European countries and Japan generally have higher motor fuel taxes than do Canada and the United States. The United States and Japan have legislated automobile efficiency standards, while most other member countries rely on voluntary standards. Several countries offer incentives to industry to replace fuel oil with alternatives such as coal and natural gas. Canada is the only OECD country to incorporate specific substitution targets in its 'off-oil' program.

Canada

The federal government encourages energy efficiency and substitution for oil through several programs.

The Canadian Home Insulation Program (CHIP) encourages home owners to invest in insulation. Until late 1982, the program had provided taxable grants for 100 per cent of the cost of materials and 33.3 per cent of labour costs up to a limit of $500. Since then, the grant for both materials and labour has been restricted to 60 per cent, with no change in either the tax status or the $500 limit.

The Canada Oil Substitution Program (COSP) provides for taxable grants up to $800 for conversions from oil-based heating to systems fuelled by natural gas, electricity, wood or other non-petroleum fuels. The program supported some 405 900 conversions (145 100 to natural gas, 128 800 to electricity, and 132 000 to wood and propane) for the 31-month period prior to April, 1983.

Private owners and fleet operators who modify their vehicles to run on propane can get a $400 taxable grant per vehicle. Demonstration grants of $600 per vehicle are currently available for conversion of vehicles to use natural gas.

In addition to direct grant programs, the federal government encourages investments in energy-saving technology through accelerated capital depreciation schedules and a reduction or elimination of sales taxes. Provincial governments also support, in varying degrees, energy conservation and oil substitution.

Ontario

The Ontario government has set oil substitution and energy conservation targets for each sector of the economy (Figure 48). If these targets are reached, the increase in total energy used by the transportation, residential, commercial and industrial sectors would average only one per cent annually, less than half the 2.5 per cent annual growth experienced from 1970 to 1980.

Sector	Energy conservation targets	Oil substitution targets
Transportation	• 33% reduction in fuel consumed per person-kilometre between 1980 and 1995 for passenger transportation • 20% reduction in fuel consumed per tonne-kilometre between 1980 and 1995 for freight transportation • for Ontario government fleet, 10 per cent improvement in energy efficiency by 1983	• reduce oil share to 90 per cent by 1995
Residential	• 30 per cent improvement in average household energy efficiency by 1995 over 1980	• reduce oil share to 10 per cent by 1990
Commercial	• 20 per cent improvement in commercial building energy efficiency by 1995 over 1980 • for Ontario government buildings, 26 per cent reduction in energy consumed by 1985 over 1976	• reduce oil share to 10 per cent by 1990
Industrial	• 25 per cent reduction in energy per unit output by 1985 over 1975	• reduce oil share to 10 per cent by 1990

Indigenous energy production targets
- to produce 37.5 per cent of Ontario's primary energy in 1995 from indigenous provincial sources
- to produce at least 5 per cent of Ontario's primary energy requirements from renewable and recoverable energy sources by 1995. This target excludes the contribution of hydroelectric power.

Energy security targets for Ontario
Figure 48
The Ontario government has set oil substitution and energy conservation targets for the transportation, residential, commercial, and industrial sectors. If these targets are reached, the increase in energy requirements would average only one per cent annually, less than half of the annual growth experienced from 1970 to 1980.

This section reviews developments in conservation and oil substitution in Ontario.

Industrial sector The industrial sector is the largest energy user in Ontario. Of all the energy used by the industrial, transportation, residential and commercial sectors, industries account for about 40 per cent. Since price increases for fuel oil and natural gas have exceeded the level of inflation in the past decade, energy conservation has become an important element of cost competitiveness in the industrial sector.

Industrial sector energy conservation
Figure 49
Industries have surpassed their conservation goals for 1980. Further improvements are targeted for 1985.

	Net energy efficiency improvement (%)			
	1980 Goal	1980 Actual	1981 Actual	1985 Goal
Task force				
Chemicals	17.0	22.4	25.0	31.0
Electrical and Electronics	15.0	20.3	24.0	20.0
Farm and Industrial Equipment	15.0	10.8	7.8	20.0
Ferrous Metals	3.3	4.7	2.5	7.1
Food and Beverage	15.0	20.4	17.9	23.5
General Manufacturing	new	(0.3)	2.8	12.5
Industrial Minerals	10.0	11.3	13.8	16.9
Machinery	15.0	19.4	n.a.	22.0
Mining and Metallurgy	5.8	7.4	8.2	15.0
Non-Prescription Medicine	new	new	2.8	12.0
Petroleum Refining	17.0	18.0	20.2	25.0
Plastics	new	17.4	15.5	13.1
Pulp & Paper	12.0	17.2	17.2	30.0*
Textiles	11.0	22.3	22.5	25.0
Transportation (Manufacturing)	8.0	8.6	3.2	25.4
Wood Products (Western)	new	17.5	26.5	15.0
All Task Forces	12.0	15.4	16.3	23.0

*1984 goal

Source: Canadian Industry Program for Energy Conservation Report, 1981

Note: Percentage efficiency gains are calculated on the basis of the reduction in energy required to manufacture one unit of production in the current year compared to that required in a base year, usually 1972.

Energy efficiency improvements are taking place in industries across Canada (Figure 49). Task forces made up of industry and federal government representatives set energy conservation targets, provide energy conservation information to all Canadian industries and monitor energy-saving results. In most industries, the 1980 target was surpassed a year early and new targets have been set for 1985.

The Ontario government has a number of programs to encourage industries to conserve energy and replace oil with less expensive and more abundant forms of energy. The government's target is to reduce average energy use in Ontario industries by 25 per cent by 1985 compared with the 1975 level, and to reduce oil's share to 10 per cent by 1990, compared with 18 per cent in 1981.

Under a $10 million Industrial Energy Conservation and Oil Substitution Incentive Program, the Ontario government offers grants of up to $50 000 to manufacturers who install new energy-efficient systems, or who substitute more abundant fuels for oil.

Since the program began in October, 1980, 1196 companies have applied for grants of $9 million. The companies themselves have invested $36 million. They will save about 116 million litres of heating oil a year, or the amount of energy needed to heat about 34 000 homes.

Another Ontario government initiative is the Energy Bus, a computer-equipped bus, in use since 1975 for on-site analysis of energy use and for identifying potential savings. By mid-1982, the Energy Bus had visited almost 1800 companies and highlighted more than $54-million in potential energy savings. Several companies which had initial visits in the early years of the program are taking advantage of a second visit now that energy prices are higher and potential savings more attractive.

Several Ontario industries use the excess heat they produce to generate electricity for their own use or for sale. This process is known as cogeneration. Industrial plants cogenerating electricity for their own use include Great Lakes Paper in Thunder Bay, American Can in Marathon, and Dow Chemical in Sarnia. The Abitibi Paper Company not only cogenerates electricity for its own use, but also sells some of the power to the town of Smooth Rock Falls. Other pulp and paper companies supply electricity to the surrounding towns of Marathon and Terrace Bay.

Waste heat is also available at generating stations, where only about one-third of the heat produced in the boilers is converted to electricity. Much of the remaining heat is transferred to water circulated as coolant and ultimately released in adjacent lakes and rivers. Large amounts of hot water could be used year-round for agricultural, residential and industrial purposes in the vicinity of generating stations.

Steam not needed by the electrical turbines at the Bruce Nuclear Power Development near Kincardine will supply the energy needs for a planned agricultural, commercial, aquacultural and industrial development nearby known as the Bruce Energy Centre. The centre is being developed by Ontario Hydro.

A greenhouse, which uses waste energy discharged by the adjacent TransCanada PipeLines Limited compressor station in Ramore, Ontario, is expected to produce about five million tree seedlings per year for use in Ontario reforestation programs. The facility will also grow vegetable crops on an experimental basis.

Ontario Hydro is training more than 200 energy conservation surveyors from Hydro and municipal utilities to audit the energy consumption of about 12 000 small-to-medium-sized industrial plants in the province. Ontario Hydro also conducts seminars on industrial energy conservation throughout Ontario.

Transportation sector The transportation sector, which depends almost entirely on refined petroleum products, consumes about half the oil used in Ontario. Since transportation is essential to an industrial-based economy, it must operate as efficiently and economically as possible. Conserving energy is a major way costs can be reduced.

Faced with gasoline price increases, Ontario residents have reduced their gasoline consumption by using public transit, ride sharing and choosing smaller, more fuel efficient cars. The amount of gasoline consumed per household has declined significantly in recent years (Figure 50). Between 1973 and 1982, gasoline consumption per household in Ontario declined 25 per cent. Between 1979 and 1982 alone, consumption dropped 16 per cent, reflecting the combination of sharp price increases, weakness in the economy and greater use of diesel fuel in freight transportation.

The Ontario government's conservation targets for this sector are to reduce energy demand by 33 per cent per passenger-kilometre and by 20 per cent per tonne-kilometre for freight transportation by 1995, compared with 1980 levels. A further target is to reduce oil's share in the transportation sector to 90 per cent by 1995. This calls for great use of fuels such as propane, compressed natural gas and methanol.

To help achieve these targets the provincial government has established a variety of energy saving programs. These programs are co-ordinated through the Transportation Energy Management Program (TEMP).

Ride sharing is one significant way energy consumption can be reduced. The Ontario government has encouraged major employers with more than 500 employees to form van pools. By mid-1982, 96 company-sponsored van pools had been formed, representing a saving of almost two million litres of fuel annually.

The Ontario Van Pool Organization Limited (OVPO), which is managed by the Ontario Energy Corporation, encourages greater use of van pooling by offering a van at cost to people who wish to commute by van pool. As of mid-1982, OVPO was operating 35 van pools, representing an annual saving of almost 600 000 litres of gasoline.

Trucksave, a joint industry-government program, offers information booklets and audio-visual presentations to truck fleet operators on ways to conserve fuel. For fleet operators of light vehicles (cars, vans and small trucks), the government's DriveSave program runs seminars on conserving energy. Drivers are shown how they can save between 10 and 25 per cent in fuel simply by improving their driving and vehicle maintenance habits.

Other programs help municipalities formulate transportation energy plans. Vehicle traffic flow, parking control, transit options, and all aspects of urban transportation energy management are some of the ways energy use can be reduced.

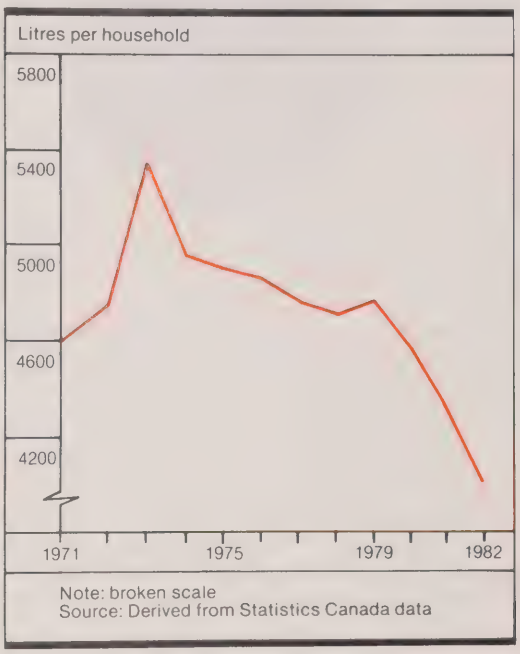
Avoiding unnecessary travel is an important part of energy conservation, particularly in a large country. The Ontario government is demonstrating different kinds of teleconferencing equipment, which allows easy communication between offices.

In its fleet operations, the Ontario government reduces fuel consumption through energy conservation criteria in equipment selection, fleet use and driving and maintenance practices.

The Ontario government removed the retail sales tax from licensed vehicles powered by non-petroleum based fuels, in 1980. Additionally, alcohol fuels, propane, and other natural and manufactured gases are exempt from the Ontario transportation fuels tax. In 1982, the retail sales tax exemption was extended to include dual fuel vehicles and conversion kits. These incentives are in addition to the $400 taxable grant offered by the federal government.

Propane costs less than gasoline. But conversion costs and accessibility are other considerations. In early 1983, propane in Ontario cost about 26 cents per litre compared with 46 cents for gasoline. Propane is 30 per cent less expensive than gasoline when heat content and combustion efficiency are taken into account. Conversions cost about $1500 per vehicle. Nevertheless, it is still an attractive investment, particularly for fleet operators and farmers, whose propane-powered vehicles qualify for federal government grants.

Between the fall of 1980 and December, 1981, the Ontario government, as part of a program known as Drive Propane, tested 306 propane-powered cars, vans and trucks from 25 companies, municipalities and provincial government ministries to assess the performance of propane in commercial fleet operations throughout Ontario. The fleet operators found propane to be an excellent



Average gasoline consumption
Figure 50
The quantity of gasoline consumed per household has declined significantly in recent years. Between 1979 and 1982 alone, per household consumption dropped 16 per cent.

alternative to gasoline. The average annual fuel cost savings per vehicle in the demonstration was $1210, or about 24 per cent of the fuel bill.

Many propane conversion centres and about 1000 refuelling stations have opened in Ontario. Currently, there are about 20 000 propane-fuelled vehicles in the province, compared with less than 1000 in 1980. The Ontario government has set a goal to have 40 000 propane-powered vehicles in Ontario by 1985. The provincial government has converted more than 400 of its own vehicles to propane, with plans to convert at least 2000 by 1987.

Several companies, including Sears, Simpson's and Bell Canada, have converted many of their vehicles to use propane. Halton Regional Police, Belgoma Transportation in Sault Ste. Marie and the Regional Municipality of Durham have also converted some or all of their cars to use propane, and the City of North York has 15 propane-powered garbage trucks.

Compressed natural gas and methanol are other fuels being tested by the Ontario government in various demonstration projects. More technological development is needed before these fuels can become widely available.

Residential sector Homeowners across the province are insulating, lowering their thermostats, adding or improving storm windows and doors, caulking and weatherstripping, in response to rising home-heating costs. These simple measures can save up to 25 per cent on heating bills.

The Ontario government's energy conservation target for homes is to reduce average household use by 30 per cent between 1980 and 1995. The oil substitution target is to reduce oil's share to 10 per cent of total residential energy use by 1990 from an estimated 28 per cent in 1981 (Figure 51).

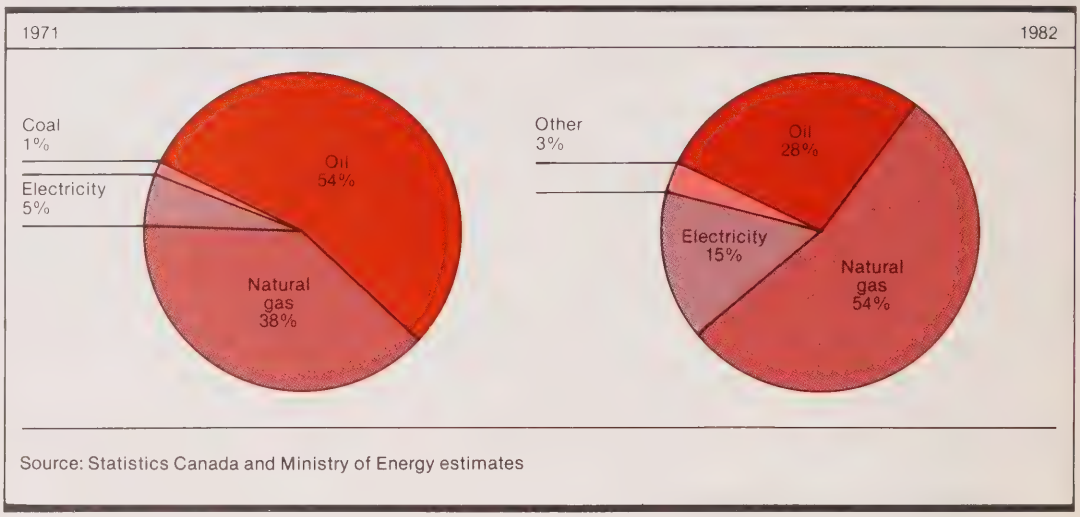
Various Ontario government programs encourage energy conservation and off-oil measures in the home. The provincial programs complement those of the federal government (such as CHIP and COSP).

The Ontario government holds free Heat Save clinics in communities across the province to give homeowners expert, personalized advice on how to make their homes more energy efficient.

At the clinics, homeowners can see a thermogram or 'heat picture' that shows if there is excessive heat loss through the roofs of their homes. The thermogram is obtained at night from an aircraft equipped with a special heat detecting device.

Between September, 1980, when the program began, and mid-1982, more than 54 000 homeowners had attended clinics in 14 communities. Community response to date, with participation as high as 65 per cent of all homeowners in Cobourg, proves homeowners are genuinely interested in finding ways to reduce their heating bills. More clinics are scheduled for communities in all parts of the province until the spring of 1986.

Residential sector energy use
Figure 51
Natural gas heated more than half of Ontario's homes in 1982. Oil supplied most of the home heating needs in 1971.

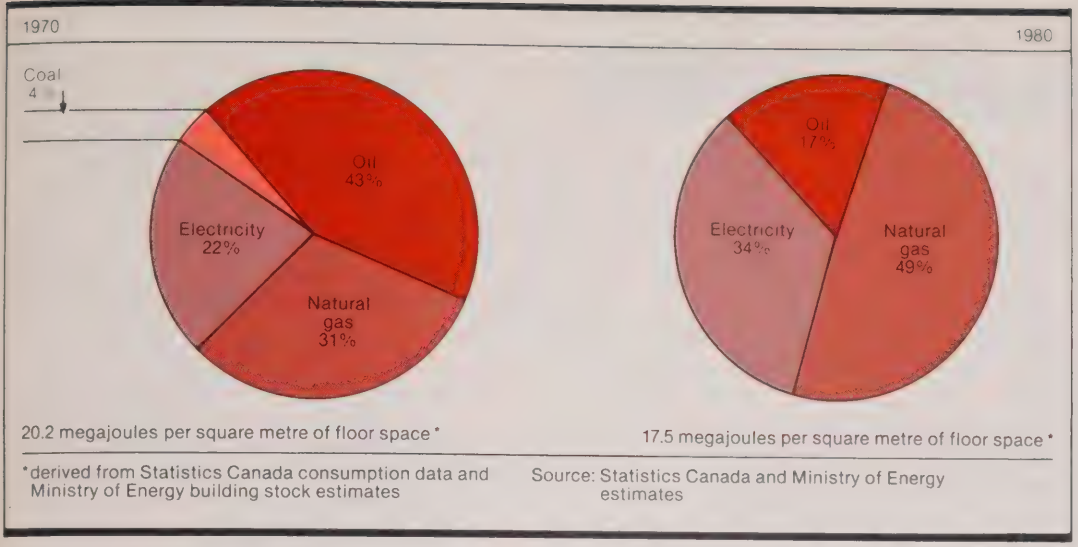


Free energy-saving house inspections for the homeowner and a reduced interest loan of up to $2000 for improving home insulation and electrical wiring are available through Ontario Hydro's Residential Energy Advisory Program (REAP). This program is run by Ontario Hydro in rural service areas and by municipal utilities in other parts of the province.

The Ontario government, through its Housing Energy Management Program (HEMP), supports research and development on upgrading existing houses, and on equipment and standards for future housing construction. Projects under development include more efficient insulation techniques, methods to reduce the thermal conductivity of masonry walls, improvements to heating systems, and methods of central heat control in high rise buildings.

Research by the Canadian Gas Research Institute, funded in part by the Ontario government, led to the development of high-efficiency residential gas furnaces that achieve nearly 92 per cent seasonal efficiency. Several models are now available in the Canadian retail market.

Energy conservation messages are promoted in Ontario classrooms. Audiovisual materials, booklets and energy models developed by the Ontario government's energy



Commercial sector energy conservation
Figure 52
Commercial use of natural gas and electricity is growing in relation to oil and coal. At the same time, energy is being used more efficiently.

education program are used in primary, junior high and high schools across the province. The government also holds seminars to provide teachers with energy information, teaching aids and assistance in developing new teaching approaches and materials for the classroom.

In response to the federal government's off-oil grants and rising oil heating costs, large numbers of homeowners are converting their heating systems to natural gas or electricity from oil. In the 31-month period to April, 1983, about 159 300 Ontario homeowners made this change, with 57 per cent choosing natural gas, 22 per cent opting for electricity, and 21 per cent electing wood or propane.

Of the estimated three million residential units (including apartments) in Ontario in 1982, approximately 54 per cent were heated by natural gas, 28 per cent by oil, 15 per cent by electricity, and the balance by wood and propane (Figure 51). This is a substantial difference from only 11 years earlier, when oil supplied 54 per cent, natural gas heated 38 per cent, electricity five per cent, and coal provided the remaining one per cent. The changing picture is partly due to off-oil conversions. Also, most of the three-quarters of a million new units constructed during that time were built with natural gas or electric heating systems.

Commercial sector The commercial sector includes a wide variety of non-industrial structures such as warehouses, office buildings, schools, hospitals, and churches. These buildings differ in their patterns of energy use. Hospitals require large amounts of energy at all times, while other buildings, such as offices, schools and churches, are occupied only part of the time.

Despite the differences in energy requirements, commercial and institutional buildings share a common problem: growing energy costs and how to reduce them.

By using alternatives to high-priced heating oil, the commercial sector has reduced its energy costs. Its dependence on oil has dropped substantially, from 43 per cent in 1970 to 17 per cent in 1980 (Figure 52).

Energy has been saved through fairly simple conservation measures, such as reduced lighting, turning lights off earlier in the evening and shutting off mechanical systems, such as heating and cooling systems, whenever possible. In 1980, the total commercial sector used 13 per cent less energy per square metre of floor space than in 1970.

The Ontario government has a variety of energy conservation programs for Ontario government-owned and government-funded buildings, private commercial buildings, and religious buildings.

These initiatives are designed to help reach the following energy conservation targets: a 20 per cent efficiency improvement in commercial and institutional buildings by 1995 over 1980; a 26 per cent reduction in energy use by 1985 over 1976 for Ontario government-owned buildings; and a reduction in oil's share to 10 per cent by 1990 compared with about 13 per cent in 1981.

The Ontario government has implemented energy-saving measures in almost 3000 of its buildings across the province since 1975. At that time, it was expected energy use could be reduced 15 per cent in five years. By the fifth year, the amount of energy used in Ontario government buildings was reduced almost 25 per cent, representing savings of over $27-million on a $12-million investment. Also, off-oil conversions have been completed in about 200 government-owned buildings.

In 1981, the Ontario government introduced a $12 million conservation program for public buildings not owned, but funded, by government, such as schools, universities and hospitals.

The Ontario government also runs a variety of programs to help Ontario's municipalities accelerate their conservation efforts. Municipalities are offered land-use planning grants and cost-sharing grants for off-oil conversions and thermal improvements in municipal buildings, and for the employment of qualified energy conservation auditors. Also, communities are receiving assistance in developing energy management plans.

Energy Outlook

Primary energy demand *– Oil could supply about one-quarter of Ontario's primary energy needs by 2000, down from more than one-third today.*

Oil *– A rapid reduction in oil demand and stronger conservation and substitution initiatives are needed to achieve Canadian oil self-sufficiency by 1990.*

Natural gas *– Canada's large conventional natural gas supply is expected to be supplemented by supplies from the country's frontier regions.*

Electricity *– The province's strength in energy production lies in electrical power generation.*

Conclusion *– By reducing its dependence on oil, Ontario is contributing to the national goal of oil self-sufficiency.*

Energy demand projections for Ontario

The first part of this report outlined Ontario's present energy picture. This part discusses prospective changes in energy markets in Ontario.

No one can predict future events exactly. However, energy supply and demand projections can help highlight various factors shaping the future and thereby point out potential problems. As a result of this knowledge, it may be possible to take appropriate action.

The Ontario Ministry of Energy has developed several models to project long term energy demands based on expected technological changes and socio-economic developments. To account for the many possible outcomes in the energy demand picture, the models allow certain basic assumptions to be altered, giving a range of possible consumption patterns.

Two plausible demand scenarios for the period to the year 2000 were developed for the province in mid-1982. The following assumptions were used in both cases:

- Technological progress will be maintained, but without major breakthroughs;
- Only the policy measures that are now implemented, or expected to be implemented, are considered;
- No major social or political upheaval will radically change the structure and pattern of energy use;
- The marketplace will continue to determine resource allocations;
- Consumers and industries will pursue economic energy conservation opportunities;
- "Renewable" energy sources, other than water-power, will make only a small contribution to Ontario's total needs until at least the end of the century;
- Over the period of the Ottawa/Alberta Agreement (1981-1986), the provisions defining relationships between domestic and world oil prices will remain intact;
- The federal government will pursue its expressed intentions to keep the City Gate natural gas price at approximately 65 per cent of the refinery gate oil price in Toronto, over the 1982 to 1986 period;
- There will be not further deterioration in the international economy. At the same time, the magnitude of existing problems makes it improbable that industrialized countries will quickly return to high and sustained long term growth;
- The population in Ontario will grow much more slowly than in the past, and the number of persons in the middle and senior age brackets will steadily increase.

A more detailed description of the assumptions is presented in Figure 53.

The two cases differ in their assumptions of future population and economic growth, energy prices, improvements in the efficiency of energy use, and the use of known energy-efficient technologies. The differences are as follows:

Case A – This scenario assumes that Ontario's population will grow at 0.8 per cent per year in the 1980 – 2000 period (compared with 1.3 per cent per year in the 1970s). It also anticipates a gradual international economic recovery and moderate long term economic growth. For energy prices, this case assumes the City Gate natural gas price after 1986 will rise to 75 per cent of the blended oil price by 1996. Increases in the price of electricity are assumed to be lower than for oil and gas in the 20-year period to 2000.

Case B – This case assumes a higher population growth rate (one per cent per year from 1980 – 2000), along with a faster international economic recovery and stronger long term growth than in Case A. The major difference is energy prices between the two cases concerns natural gas pricing. Case B assumes the City Gate natural gas price remains at 65 per cent of the oil refinery price over the full 20-year period. This results in lower overall energy prices than in Case A since other fuel prices remain the same in both scenarios.

Secondary Energy Demand

The projections of secondary energy demand relate to energy use in the industrial, transportation, residential and commercial sectors.

The industrial sector consists of agriculture, mining and manufacturing; the transportation sector includes road, rail, air and marine transportation of people and goods; the residential sector covers households; and the commercial sector includes a range of government and privately-owned commercial buildings.

Energy used by refineries, pipelines and electrical generating stations and the oil used for non-energy purposes such as plastics, lubricating oil and nylon are excluded from the calculations of secondary energy demand.

The projections for the four sectors were developed by estimating the size and the characteristics of the future stock of buildings and energy-using machines and appliances, and by estimating the different amounts of energy each would use.

Secondary energy use in Ontario between 1980 and 2000 is expected to grow at a slower pace than in the 1970s. The expected future growth rate is one per cent per year until the end of the centure for Case A and 1.4 per cent per year for Case B, compared with a 2.5 per cent annual increase in the 1970s.

Energy use in the industrial sector will probably grow faster than in the other three sectors. By the year 2000, industries could require almost half of the total secondary energy used in the province, a significant

Ontario energy demand projections major assumptions for cases A and B
Figure 53
These are major assumptions underlying the long term energy demand projections done by the Ministry of Energy.

Sector	Conservation	Fuel Choice
Residential Old Housing	22% reduction in heat requirements through thermal upgrading by 2000	Heavy conversion from oil to natural gas and electricity Faster rate of conversion to natural gas assumed in Case B
New Housing (built after 1980)	33% reduction in heating requirements through improved design and building practices by 2000	primarily natural gas and electricity
	Oil and gas furnaces to increase in efficiency by 8 and 12% respectively by 2000 Appliances to increase in efficiency by 10% by 2000	
Commercial Old Stock	10% reduction in energy consumption by 1990 for education buildings and 13% for office buildings; 7% average reduction by 1990 for all commercial buildings	Existing buildings will be heated primarily by natural gas in 1990 (about 73%) oil will heat 17% and electricity 10% Small contribution from solar by 2000 Higher natural gas penetration (76% in 1990) assumed in Case B
New Stock	Average new building in the mid-eighties will consume approximately 33% less energy than average existing building in 1980 Largest improvements are projected in space heating (39%) and lighting (45%)	New buildings in 1990 will be heated primarily by natural gas and electricity (64 and 29% respectively). In 2000 natural gas share falls to 49% while electricity increases to 41% Increased use of heat pumps, especially after 1990 Higher natural gas penetration in Case B, at expense of electricity
Industrial	Canadian industry energy conservation goals of 7.6% by 1985; further savings of 5-10% for fossil fuel and 3-5% for electricity by 2000 New capacity expected to have fossil fuel needs 15-25% below existing capacity Somewhat lower conservation levels are assumed for natural gas in Case B due to its lower relative price	Increased coal penetration (26-28% by 2000 from 24% in 1980) No significant increase for self generation of electricity except pulp and paper with hydraulic self generation growing at an annual rate of just under 1% over 1980-1990 period Case B does not assume substitution of coal for natural gas in industries where there is currently little or no coal consumption
Transportation	Fuel economy will increase most rapidly up to 1986 then slower rates of increase up to 2000 No major technological development assumed in bus, train, transit and marine modes, although air transportation has largest scope for efficiency improvement	Increased dieselization of trucks Dieselization of automobile fleet to reach 8.6% by 2000 Little contribution from non conventional fuels such as methanol, ethanol and compressed natural gas before end of century Growing contribution expected from propane powered vehicles

All Sectors: Basic Socioeconomic factors (% growth rate per year)

	Case A	Case B
Population (1980-2000)	0.8	1.0
Real Gross Provincial Product (1980-2000)	2.5	3.0

increase from their 39 per cent share in 1980. One-quarter could be required for transportation purposes. The residential sector, the third largest energy-using sector in Ontario, could account for about 16 per cent, down from its approximate one-fifth share in 1980. The balance, slightly more than 10 per cent, could be used by the commercial sector (Figure 54).

Slower population growth and the aging of the population will tend to slow down the growth rates of the transportation, commercial and residential sectors in relation to the industrial sector. In addition, the potential for energy efficiency improvements is probably greater in the other sectors because industries have already implemented many of the economical conservation measures available.

Between 1970 and 1980, gas and electricity gained a larger share of the energy market, while the oil and coal shares decreased (Figure 55). Over the forecast period, the shares for electricity and coal are projected to increase, while the oil share would continue to decrease. Expected greater use of coal in the industrial sector and of electricity in the residential sector account for the decline of natural gas in the 1990s. Coal for iron and steel production accounts for most of the industrial sector's coal consumption. By the end of the century, refined petroleum products are forecast to decline to about 94 per cent of the transportation sector's energy needs, down from almost 100 per cent today. The difference is expected to be met by fuels such as propane, ethanol, methanol and compressed natural gas.

Primary energy demand

Primary energy is made up of secondary energy plus the energy used by the energy supply industries and that contained in non-energy products.

Ontario's total primary energy demand could grow at an average annual rate of 1.2 - 1.5 per cent in the 1980 - 2000 period. This is less than half the growth rate in the 1970s and far less than the 5.3 per cent growth in the late 1960s. Slower economic growth in the 1980s, rapid energy price escalation, conservation and slow population growth will probably restrain the growth in future demand for all fuels.

Oil's share of total primary energy should decline from 37 per cent in 1980 to approximately 25 per cent by the year 2000, while natural gas is expected to continue to supply more than one-fifth of Ontario's energy needs (Figure 56). Case B (Figure 56) suggests a

larger share for natural gas because this scenario assumes more favourable gas pricing relative to other fuels and improved prospects for the economy. With the increased nuclear generation of electricity, uranium might provide about one-quarter of the province's total energy requirements while water-power might contribute about 10 per cent by the year 2000.

Secondary energy demand by sector

Industrial sector The industrial sector will likely be the fastest growing energy user in Ontario throughout the rest of this century.

Three industries – iron and steel, industrial chemicals, and pulp and paper – currently account for about half of the industrial sector's energy requirements. The iron and steel industry uses most of its energy fuels (60 - 70 per cent) as coking coal, which is used for both its chemical properties and its heat value. Efforts to reduce energy demand in the iron and steel industry include a phasing out of the open hearth furnace in favour of a basic oxygen furnace.

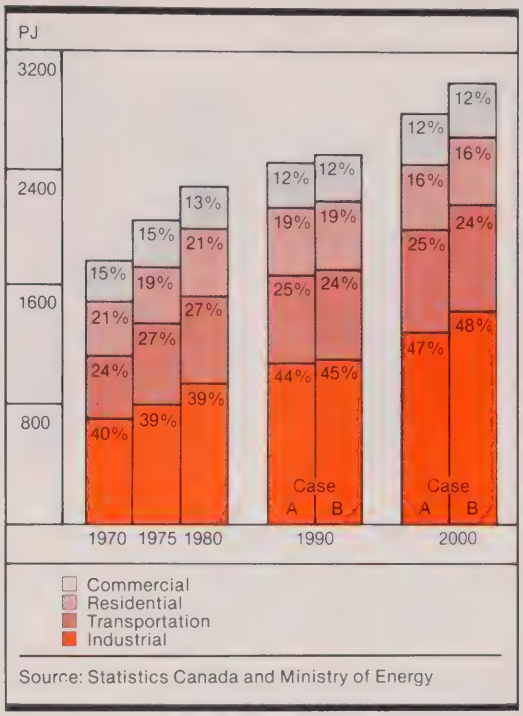
The impact of energy conservation in the industrial sector is projected to be more modest than in the other sectors. This is partly because industry has already done much to restrain its energy use and costs. However, as industry expands and as new plants replace old ones, new and more efficient processes will be chosen.

Industries, particularly pulp and paper, are expected to generate more of their own electricity in the future. The potential for new, cost-effective, industrial cogeneration in Ontario before 2000 is estimated to be 500 -1000 megawatts (MW), in addition to the 600 MW now in place, or about two to four per cent of Ontario Hydro's existing generating capacity. The pace of this development will depend heavily on future electricity prices in relation to fossil fuels, and the availability of investment capital.

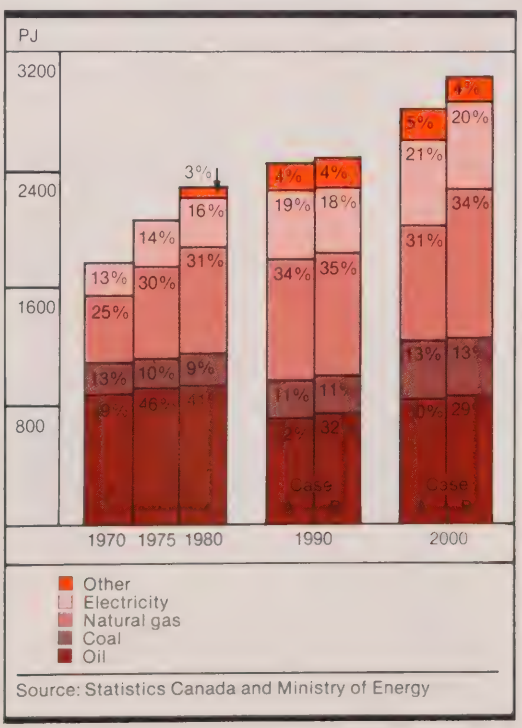
Between 1970 and 1980, the shares of oil and coal used in the industrial sector declined (Figure 57). Oil's share fell from almost one-quarter to 15 per cent, principally during the second half of the decade largely because of oil price increases since 1973. Both oil and coal were displaced by natural gas, whose share rose to 41 per cent in 1980. The use of wood was negligible in 1970, but supplied five per cent of industrial energy needs in 1980. Meanwhile, the electricity share remained at 15 per cent. These changes in market shares occurred while the industrial energy market expanded at an average annual rate of 2.2 per cent.

In the years ahead, oil's share should continue its decline, to about 10 per cent of industrial energy requirements in the year 2000. Coal use is expected to increase during the forecast period in both cases, with a projected 26 - 28 per cent share in 2000. The electricity share is also projected to grow as price competitiveness improves over the forecast period. Natural gas is expected to maintain approximately the same share of the energy market until the end of the century. The shift to natural gas will probably be limited, in part, by recent and prospective increases in its price relative to coal and electricity. Wood wastes and other forms of energy are expected to provide six per cent of industrial energy needs in 2000.

Between 1980 and 2000, total industrial energy demand is expected to grow at an average 1.9 per cent for Case A, representing total growth of 46 per cent. Case B projects a greater annual increase in energy use of 2.4 per cent or a total growth of 61 per cent during the forecast period. This larger demand reflects primarily higher economic growth.



Secondary energy use by sector 1970-2000
Figure 54
Ontario's secondary energy requirements will continue to grow, but much more slowly than in the past. Industrial use is expected to expand more rapidly than demand in other sectors.



Secondary energy use by fuel 1970-2000
Figure 55
Oil will diminish in relative importance, but will remain a significant secondary energy source at the turn of the century. Natural gas and electricity will meet most of the growth in energy requirements.

Transportation Sector Transportation is Ontario's second largest energy using sector. Refined petroleum products supply almost all of the energy used in transportation. Gasoline alone accounts for about three-quarters of total energy consumption.

Transportation energy requirements grew at an annual rate of 3.7 per cent between 1970 and 1980 (Figure 58). Growth is expected to be more moderate to the end of the century, with an average increase of 0.6 - 0.8 per cent per year. The lower rate is due largely to an expected slowdown in population growth, greater use of more efficient fuels such as diesel and improved fuel economy standards for new automobiles. In air travel, improved aerodynamics, new lightweight materials, higher seating densities, amd changes in fuel specifications and engine design should result in decreased energy consumption. In freight transport, technological improvements, improved operations and changes in regulatory procedures should bring efficiency gains.

Between 1970 and 1980, gasoline's share of the transportation sector's energy requirements fell to just under three-quarters, from almost 80 per cent. The difference was met mainly by diesel fuel; its share rose from nine per cent in 1970 to 15 per cent in 1980.

In both Cases A and B, these trends are expected to continue. Between 1980 and 2000, the demand for gasoline is likely to decrease at an average of 0.5 - 1.1 per cent annually. At the same time, diesel consumption is projected to increase 3.4 - 3.8 per cent per year. Most of this increase will be in the trucking sector. A number of constraints may limit the use of diesel as an automobile fuel, including poor performance in cold weather, emission problems and a possible increase in its relative price.

Over the forecast period, oil's share is expected to drop slightly. By the year 2000, refined petroleum products are forecast to meet about 94 per cent of total energy demand, compared with almost 100 per cent at present.

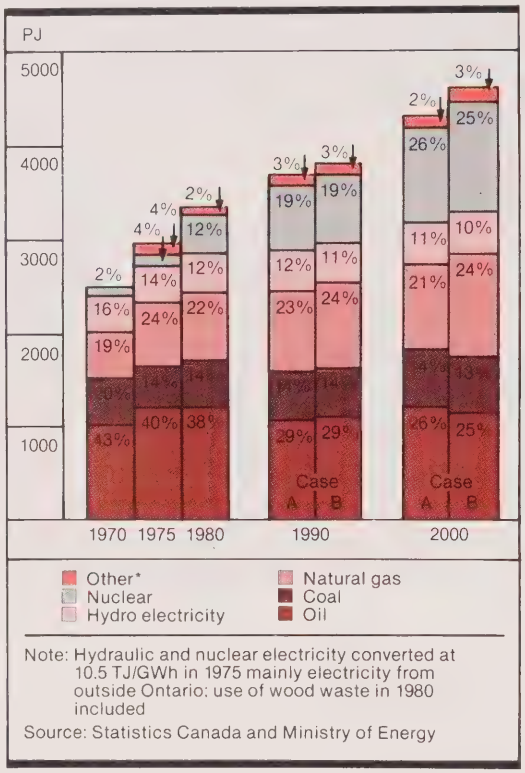
Propane is an emerging, less expensive substitute for gasoline. Although negligible in 1980, its share could reach two per cent by 1985, and almost five per cent by the year 2000. By the end of the century, 200 000 Ontario vehicles might be fuelled by propane.

Other substitutes, such as methanol, ethanol and compressed natural gas, are not likely to have a significant role in the transportation sector up to 2000 due to their high cost and technical and supply problems. To help overcome these obstacles, the Ontario government sponsors a wide variety of alternative fuel demonstration projects.

Residential Sector Residential energy demand consists of all the energy used for household purposes. Space heating currently accounts for nearly three-quarters of this amount, water heating 15 per cent, and appliances, lighting and other needs account for the remainder. By the year 2000, space heating is projected to account for only 64 per cent of residential sector energy needs, as a result of further conservation efforts, more efficient heating systems and more energy-efficient construction of new homes and apartments.

In Cases A and B, total household energy use is expected to remain relatively unchanged between 1980 and 2000. This is due primarily to slow population growth and a reduced rate of housing construction, together with projected improvements in energy efficiency. Upgrading existing housing, energy conserving design in new housing and the introduction of more efficient appliances and heating systems will

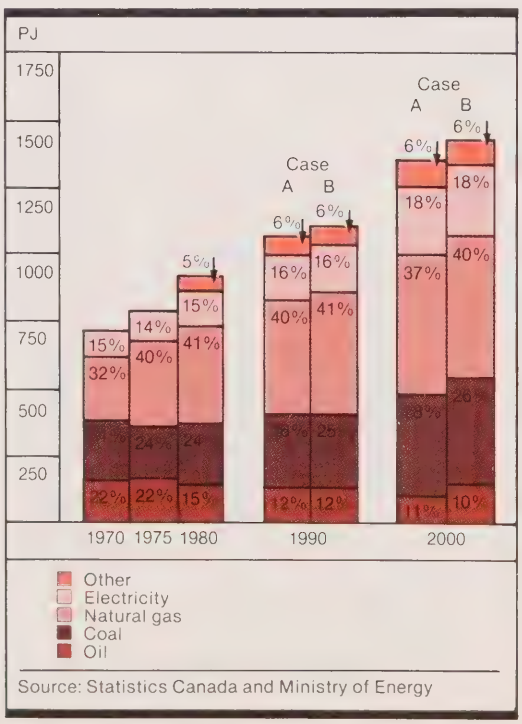
Primary energy use 1970-2000
Figure 56
The province will probably meet four-tenths of its primary energy requirements from nuclear generation and water-power and other renewable energy sources by 2000.



Note: Hydraulic and nuclear electricity converted at 10.5 TJ/GWh in 1975 mainly electricity from outside Ontario; use of wood waste in 1980 included

Source: Statistics Canada and Ministry of Energy

Industrial energy use 1970-2000
Figure 57
Industrial energy use is expected to grow as much as 60 per cent over the 1980-2000 period. Oil consumption should continue its recent decline relative to other fuels.



Source: Statistics Canada and Ministry of Energy

contribute to reduced energy consumption.

Oil's share of the residential energy market is expected to continue to decline. This will be due to off-oil conversions and reduced oil heating use in new buildings. Oil's share will be made up chiefly by natural gas and electricity. By 2000, oil might provide only five to six per cent of total residential needs, a fraction of its 48 per cent share in 1970 (Figure 59). Natural gas is expected to provide more than half of residential energy needs by the year 2000, while electricity is projected to supply one-third. Natural gas could meet about 65 per cent of space heating needs and 54 per cent of water-heating requirements by the year 2000. Electricity should supply approximately 26 per cent and 40 per cent respectively of these household uses. Remaining needs could be filled by oil, wood, propane and solar energy.

Active solar energy systems could displace about two per cent of total residential energy requirements by the end of the century. Most of this energy would be used for domestic water heating and heating swimming pools.

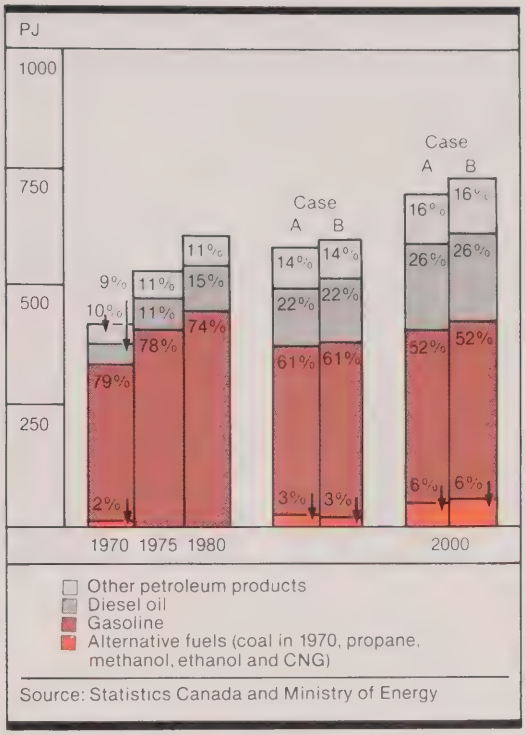
Commerical Sector Total energy demand in the commercial sector, which includes educational facilities, hospitals and religious buildings as well as private commercial offices, stores and hotels and municipal buildings, is expected to grow more slowly during the rest of the century (Figure 60). The average annual growth rate over the 1980 - 2000 period is projected to be between 0.6 and one per cent, significantly lower than the 2.3 per cent per year experienced in the 1970 - 1980 period.

This outlook is due primarily to expected lower economic growth and continued energy conservation efforts. Lower economic growth will reduce the rate of construction of commercial buildings, and government spending restraint will limit the construction of institutional buildings. Improved heating and lighting, reductions in heat loss, more energy efficient construction, and some switching from fossil fuels to electricity will also contribute to this slower growth.

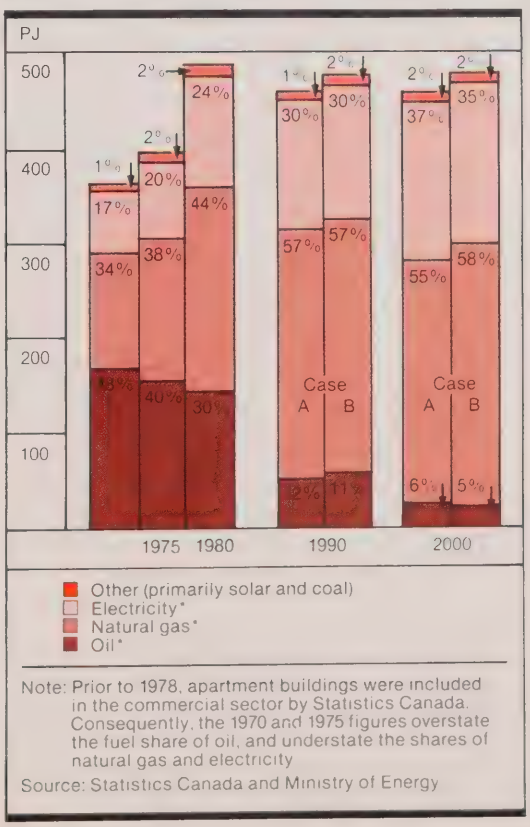
Oil currently supplies less than a fifth of the commercial sector's energy requirements. This is substantially less than its 43 per cent share in 1970. At the same time, coal use has virtually disappeared. Natural gas and electricity have replaced these fuels.

Energy use in the commercial sector is expected to be only 13 per cent higher in the year 2000 than in 1980 according to the Case A projection. The Case B projection, however, suggests that use might be 21 per cent higher in the year 2000 than in 1980 due to a more rapid growth in building stock and the greater use of natural gas for heating. In both cases, oil consumption is anticipated to decline at an average five per cent per year to the end of the century, reflecting a rapid off-oil shift.

By the year 2000, oil is projected to have only a five per cent share. Electricity's share is expected to increase significantly, particularly in the 1990s as its price competitiveness improves and heat pump penetration increases. By the year 2000, electricity could provide about half of the commercial market's needs, compared with less than one-quarter in 1970. The share of natural gas would probably stay virtually the same, approximately two-fifths, during this period. A marginal contribution is expected from solar and coal.



Transportation energy use 1970-2000
Figure 58
Gasoline will remain the principal transportation fuel. However, the market for diesel oil could expand significantly.

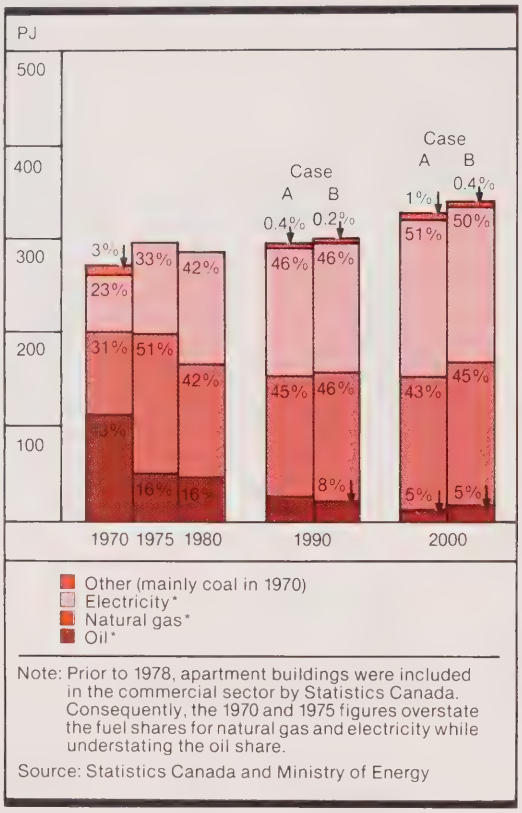


Residential energy use
Figure 59
Homeowners will become even more conscious of the need to use energy wisely. Despite growth in Ontario's population, households will likely use as much energy in the year 2000 as currently.

Prospects for Supply

By the year 2000, Ontario will likely consume 50 to 60 per cent more electricity, 25 to 50 per cent additional natural gas, 15 per cent more coal and about 10 per cent less oil than at present. In the year 2000, Ontario will probably need 30 billion cubic metres of natural gas, 20 million tonnes of coal, 2600 tonnes of uranium, and 46 million megawatt hours of hydro-electricity. Despite the reduction in projected oil demand, about 30 million cubic metres of this fuel might be required by the turn of the century. Nearly 75 per cent of this might be needed for transportation and petrochemical uses.

Commercial energy use 1970-2000
Figure 60
Energy demand in the commercial sector is expected to grow slowly throughout the rest of the century. Electricity and natural gas will increasingly replace oil.



Note: Prior to 1978, apartment buildings were included in the commercial sector by Statistics Canada. Consequently, the 1970 and 1975 figures overstate the fuel shares for natural gas and electricity while understating the oil share.

Source: Statistics Canada and Ministry of Energy

Ontario relies heavily on outside sources of supply for its energy and therefore depends on the decisions of other governments, principally in Canada. While Ontario gets most of its oil from Western Canada, the eastern provinces rely on supplies from unstable world oil markets. In the event of a world oil supply crisis, available Canadian oil supplies would be shared with these provinces and, if required, with member nations of the International Energy Agency. Clearly the risks faced by Ontario, and Canada as a whole, are a failure to accelerate the development of domestic petroleum resources, and potential disruptions in international crude oil supplies.

The following is a brief discussion of Ontario's energy supply prospects.

Oil Production from established conventional oil reserves in Western Canada will decrease significantly to an estimated one-third of the current level by the early 1990s. New discoveries of western conventional oil are expected to offset partially the drop in old conventional oil production. Tertiary recovery and other new methods of oil extraction will make a growing contribution, but they are also not expected to compensate completely for the decline in conventional production.

Two major oil supply projects, Alsands and Cold Lake, have been postponed. Therefore, the additional production anticipated from these plants in the 1980 National Energy Program (NEP) is unlikely to materialize in this decade. While these large projects have been postponed primarily because of major financial and economic uncertainties, smaller projects such as the Suncor expansion and the Leming plant near Cold Lake are underway.

Furthermore, there is evidence of major deposits in the frontier areas and off the east coast. According to the NEP Update, significant production is expected from the frontier lands in this decade. The federal government encourages industry to develop these and to find other new deposits. Through Trillium Exploration Corporation, the Ontario Energy Corporation participates in the search for oil and gas in the frontier areas.

Ontario supports the national goal of self-sufficiency in oil by 1990. The prospects for additional domestic supply suggest, however, that this objective will require a rapid reduction in the demand for oil through stronger conservation and substitution initiatives in the next few years. In the longer term, further reductions in oil demand will require technological development, especially in the transportation sector.

Natural gas Alberta provides 98 per cent of Ontario's natural gas supply. In a 1979 review of natural gas removal applications, the Alberta Energy Resources Conservation Board estimated the province's potential reserves to be around 3700 to 4000 billion cubic metres. The January, 1983 National Energy Board (NEB) report on natural gas exports indicates that Canada's established reserves and expected future additions would be more than adequate to meet domestic requirements until the late 1990s.

Eventually, the conventional gas supply from Alberta is expected to be supplemented or replaced by supplies from the Mackenzie Delta, the Beaufort Sea, the Arctic Islands and other offshore areas. Since exploration in these regions is still in its preliminary stages, more work is needed before supply and production estimates can be made.

Natural gas producers recently received authorization from the federal government for a substantial increase in natural gas exports. Additional exports should provide a needed boost to the gas industry's cash flow for continued exploration and development. However, since such large exports could be met only from conventional sources, there is the risk of increased reliance on high cost areas for future supplies to the domestic market.

The Ontario government has intervened in all of the NEB's gas export hearings to ensure

that Ontario's future needs will continue to be protected.

Coal Total coal consumption in Ontario could increase by approximately 14 per cent, from 18 million tonnes at present to nearly 20 million tonnes, by the year 2000. Coal demand for steel-making is expected to increase by about one per cent a year until 2000 while its use in generating electricity will likely decline.

This expected consumption is small compared with the vast reserves of coal that exist in Western Canada. Coal therefore represents a fairly secure long-term energy source in Canada. Research, development and demonstration programs are currently underway in Canada and throughout the world on coal gasification, coal liquefaction, fluidized bed combustion and petrochemical uses. Such technological developments, including means to reduce the level of acid gas emissions, could have a significant effect on the rate of development of Canadian coal reserves.

Electricity Future growth in electrical energy use is expected to be slower than in the past. However, the market for electricity will probably grow faster than the overall energy market. The province's generating system is being expanded to meet potential future demands. About 8500 MW of additional nuclear capacity is currently under construction or planned for service by 1995. Ontario Hydro has contracted for supplies of uranium from within the province as well as from Saskatchewan. Also, new supplies of electrical power might come from expansion of cogeneration facilities in the industrial sector. Timely approvals for transmission corridors will improve the security of power supply throughout the province.

Conclusion

Significant dependence on oil continues to be Canada's and Ontario's major energy problem. Production from the country's oil sands and offshore resources is needed to achieve Canadian self-sufficiency in oil.

Since Ontario consumes about one-third of all the oil needed in Canada, the province can play a crucial role in helping the country reach oil self-sufficiency. As this Energy Outlook section indicates, the province is expected to be much less dependent on oil at the end of this century than at present.

Canada and Ontario will not be totally isolated from world energy problems. However, increased self-sufficiency in oil combined with continued conservation and off-oil efforts could alleviate the worst effects of possible world oil shortages.

Glossary

Glossary of selected terms

API-Degree(s) A relative measure of the specific gravity, hence quality, of crude oils. Crude oils with a higher value of API have a lower density. API is the American Physical Institute. In general, the lower the number of API-Degrees the lower the quality of the oil.

Bitumen A naturally occurring viscous mixture composed mainly of hydrocarbons heavier than pentane. The mixture may contain sulphur compounds and in its natural state is not commercially recoverable through drilling wells.

Capacity, Electrical The electrical power that a piece of equipment can generate, utilize or transfer, and is expressed in kilowatts or some multiple thereof. See also Energy, Electrical.

City-Gate Price The average price charged by a natural gas transmission company for gas delivered at a 100 per cent load factor at the point of delivery, or sale, to a gas distribution company.

Co-generation Energy conversion system which produces both electricity and steam for process or heating uses.

Conventional Producing Areas Those areas of western Canada which have a long history of oil and gas production. See also Frontier Areas.

Crude Oil and Equivalent Hydro-carbons Sometimes referred to as 'Crude Oil and Equivalent'. Includes crude oil, synthetic crude oil produced from oil sands plants, and pentanes plus.

Electrolysis The decomposition of a compound into its components caused by the passage of an electric current through it. The decomposition of water to yield oxygen and hydrogen is a well known application.

Energy, Electrical Energy capability is the product of capacity multiplied by time, and is expressed in kilowatt hours, or some multiple thereof. See also Capacity, Electrical.

Established Reserves Those reserves recoverable under current technology and present and anticipated economic conditions, specifically proved by drilling, testing or production, plus that portion of contiguous recoverable reserves that is judged or interpreted to exist, from geological, geophysical or similar information, with reasonable certainty.

Feedstock Raw material supplied to a refinery or petrochemical plant.

Fossil Energy (Fossil fuel) Energy derived from crude oil, natural gas and coal; also shale oil and oil recovered from tar sands. Fossil energy by implication is the energy derived from rock beds containing the fossilized remains of marine plants and animals.

Frontier Areas Those areas of Canada which have a potential for but no history of production. These include the Mackenzie Delta-Beaufort Sea area, the Arctic Islands and the offshore areas.

Fuel Efficiency The amount of useful output energy when a fuel is burned, expressed as a percentage of the theoretical input energy content of the fuel. Fuel efficiencies are less than 100 per cent partly because of waste heat generation.

Heavy Crude Oil A term applied to crude oils with a low API gravity. Generally this is crude oil with API gravity of less than 25°.

Heavy Fuel Oil Heavy fuel oil generally includes No. 5 and No. 6 bunker fuel oils and also industrial fuel oil produced as a residual of oil refining.

Hydroelectric Generation Conversion of the energy of falling water to electric energy.

In Situ Recovery With reference to oil sands deposits, the use of techniques to recover bitumen in place, without mining the sands. Usually the bitumen must be heated in order to make it flow.

Light Crude Oil A term applied to crude oils with a high API gravity, i.e. 25° or higher.

Liquefied Petroleum Gases (LPG) The hydrocarbons propane and butanes, or combinations thereof.

Natural Gas Gaseous forms of petroleum consisting of mixtures of hydrocarbon gases and vapors. Methane is the main constituent.

Natural Gas Liquids Those hydrocarbon components recovered from raw natural gas as liquids by processing through extraction plants. These liquids include ethane, propane, butanes, and pentanes plus or a combination thereof.

Netback The revenue available to the producer to pay the supply cost, that is, total revenue less payments to governments.

Oil Sands Deposits of sand and other rock aggregate which contain bitumen, found in Alberta and Saskatchewan.

Peaking Capacity Electricity generating equipment which is operated to supply peaks in demand of the power system (usually low capital and high operating cost).

Pentanes Plus A volatile hydrocarbon liquid composed primarily of pentanes (C_5H_{12}) and heavier hydrocarbons. Generally, a by-product obtained from the production and processing of natural gas.

Proven reserves Oil which has been discovered and determined to be recoverable but is still in the ground.

Pulping Liquor (also known as waste liquor or black liquor) A substance primarily made up of lignin, a substance found in wood. It is a by-product of the manufacture of chemical pulp, and can be burned in a boiler to produce steam or electricity.

Refinery-Gate Price The delivered price of crude oil to a refinery, including all transportation charges to that point.

Shale Oil A synthetic oil obtained by heating the hydrocarbon kerogen found in certain kinds of shale deposits and condensing the vapours.

Solar Active A system which uses collectors to gather solar radiation and transfers heat by using pumps, fans, or other mechanical devices.

Solar Passive A system which collects solar radiation directly for space heating, water heating or other similar purposes without using mechanical devices.

Synthetic Crude Oil Crude oil produced through treatment of bitumen in upgrading facilities designed to decrease its viscosity and sulphur content. See also 'Bitumen'.

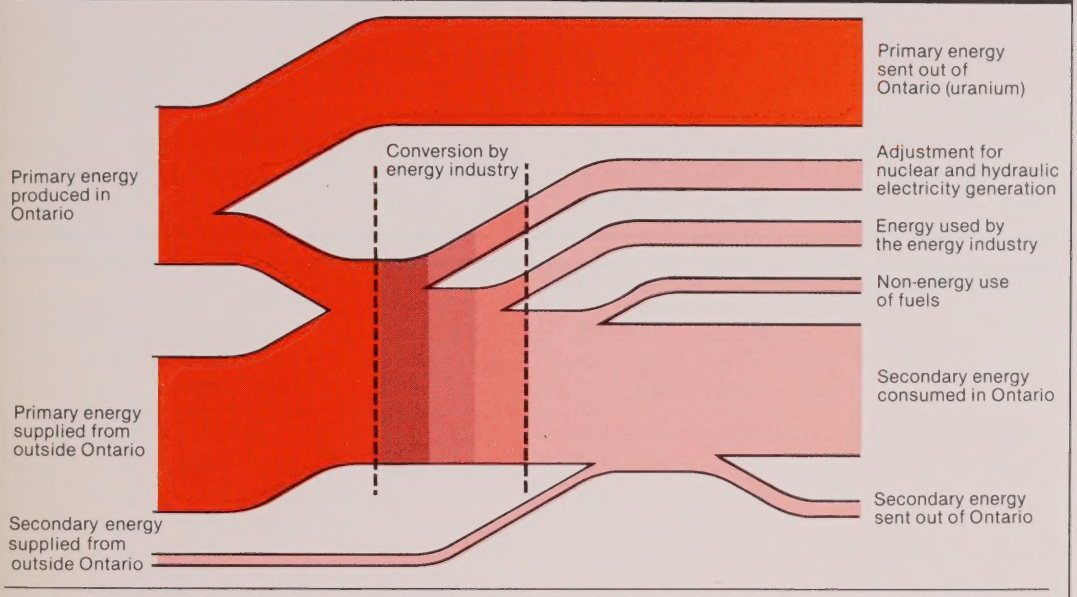
Synthetic Natural Gas Synthetic or substitute gas made synthetically from petroleum liquids or coal.

Thermal Generation Production of steam to turn turbines using a fuel such as oil, coal, gas or uranium (nuclear).

Toronto Reference Price (Toronto City Gate) The price of Alberta gas delivered at Toronto, determined as an energy equivalent value of the price of crude oil at Toronto, in accordance with Federal-Alberta gas-pricing agreements.

Wellhead The equipment placed on top of a well at the surface to maintain control of the well. More generally, it is used to specify a delivery point in the production system (e.g., the wellhead price).

Primary and secondary energy in Ontario



Note: Channel sizes are proportional to energy content in 1979. Primary energy content of uranium produced for export in Ontario assumes 1 tonne of uranium is equivalent to 539.7 TJ; its secondary energy content will depend on the conversion technology used.

The 'consumption' of energy means the conversion of latent energy in nature to heat, and in particular the controlled generation of heat and light by end-users.

'Primary energy' denotes the energy content of the raw materials from which consumer forms of energy are made. 'Secondary energy' is that which is consumed. Thus crude oil is a form of primary energy, while the consumer products made from crude oil, such as gasoline, diesel fuel, and heating oil, are forms of secondary energy. Electricity is classed as secondary energy.

During the conversion process in which secondary energy forms are manufactured, some of the energy of the primary form is consumed. This energy is termed in the Review 'energy used by the energy industry.'

An adjustment is made by the use of a conversion factor (see list on opposite page) to calculate the primary energy input for nuclear and hydraulic electricity generation.

Another portion of the primary energy goes to 'non-energy use,' such as that converted into petrochemical feed-stocks in the manufacture of plastics, lubricants, and asphalt.

These three amounts as well as the secondary energy sent out of the province are excluded from Ontario's secondary energy consumption.

Conversion from SI to Imperial Units

Crude oil
1 cubic metre, or 1000 litres
(at 15°C) = 6.293 barrels (at 60°F)

Coal
1 tonne (t) = 1.102 short tons

Energy
1 joule (J) = 0.000948 BTU
kilojoule (kJ = 10^3 J) = 0.948 BTU
megajoule (MJ = 10^6 J) = 948 BTU
gigajoule (GJ = 10^9 J) = 948 Thousand BTU
terajoule (TJ = 10^{12} J) = 948 Million BTU
petajoule (PJ = 10^{15} J) = 948 Billion BTU
exajoule (EJ = 10^{18} J) = 948 Trillion BTU

Natural gas
1 cubic metre
(at 101.325 kPa and 15°C) = 35.301 cubic feet
(at 14.73 p.s.i.a. and 60°F)

Others
1 cubic metre (1000 litres)
= 219.969 Imperial gallons
= 264.172 American gallons
1 kilogram = 2.20462 pounds
1 metre = 3.281 feet
1 kilometre = 0.621 miles
1 hectare = 2.47105 acres

Energy Forms and Conversion Factors
In this publication, metric units are used primarily in accordance with the International System of Units (SI Units). Conversion factors to the Imperial System and heat value equivalence are shown below.

Heat Value Equivalence

Energy form	Heat Value Terajoules (TJ)
Petroleum (per thousand cubic metres)	
Crude oil	38.512
Motor gasoline	34.656
Aviation gasoline	33.518
Aviation turbo fuel	35.934
Kerosene	37.676
Diesel and light fuel oil	38.675
Heavy fuel oil and still gas	41.727
Petroleum coke	42.376
LPG's (per thousand cubic metres)	
Liquefied petroleum gas	27.100
Propane	25.600
Butane	28.600
Ethane	18.400
Natural gas (per million cubic metres)	37.229
Coal (per thousand tonnes)	
Anthacite	29.527
Imported bituminous	29.993
Canadian bituminous	29.295
Sub-bituminous	19.763
Lignite	15.345
Coke (per thousand tonnes)	28.830
Coke oven gas (per million cubic metres)	18.614
Electricity* (per gigawatt hour)	3.600
Other forms	
Methanol (per thousand cubic metres)	18.100
Wood (oven dried per thousand tonnes)	20.000
(50% moisture per thousand tonnes)	10.000
Municipal solid waste (per thousand tonnes)	11.400
Steam (per thousand tonnes)	2.750

*This conversion factor is the heat value and is used for secondary energy calculations. For primary energy calculations the conversion factor (10.5 TJ/gigawatt hour) is adopted for hydraulic, nuclear and purchased electricity; this is the equivalent thermal energy, assuming the efficiency of conversion is that of a coal-burning plant.

Preliminary Statistics for 1981 and 1982

Energy Form	Ontario Year 1981	Ontario Year 1982	Canada Year 1981	Canada Year 1982
Oil	thousand cubic metres/day			
Production	0.25	0.24	220.1	217.1
Consumption	87.9	78.0	274.8	246.9
Imports (excluding exchanges)	0.0	0.0	70.4	44.0
Exports (excluding exchanges)	0.0	0.0	15.1	24.1
U.S. exchange oil brought in	6.4	6.4	10.5	9.9
U.S. exchange oil sent out	6.4	6.4	10.8	9.8
Natural Gas	million cubic metres/day			
Production of Marketable gas	1.1	1.2	186.1	189.8
Consumption	52.4	50.7	123.4	125.6
Exports	0.0	0.0	59.1	60.8
Propane	thousand cubic metres/day			
Production	1.5	1.2	19.8	18.5
Consumption	2.6	2.2	9.3	7.5
Net inter-provincial purchases	4.2	4.7	0.0	0.0
Exports	3.2	3.7	11.1	11.0

Energy Form	Ontario Year 1981	Ontario Year 1982	Canada Year 1981	Canada Year 1982
Coal	million tonnes			
Production	0.0	0.0	40.1	42.8
Consumption	17.8	18.1	38.5	41.2
Imports	13.6	15.0	14.2	16.0
Exports	0.0	0.0	15.8	15.5
Uranium	thousand tonnes			
Shipments from production and inventory)	4.7	4.6	7.5	7.6
Consumption (fuel deliveries for Canada)	0.7	0.7	1.1	1.1
Exports (85% of production)	4.0	3.9	6.4	6.5
Electricity	terawatt hours			
Production (net generation)	110.9	110.7	378.5	375.4
Consumption	107.5	106.7	344.6	344.8
Net inter-provincial purchases	7.6	6.8	0.0	0.0
Net exports	11.0	10.8	33.9	31.4

Note: The statistics in the Ontario Energy Review are derived from industrial surveys and consequently become available only gradually. Consequently, many of the latest figures have had to be estimated.

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